Social Inequalities in Health-Related Behaviours : Is the grass greener on the other side ?

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Inégalités Sociales des Comportements de Santé:

L'herbe est-elle plus verte ailleurs?

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THESE

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Préambule

Cette thèse a été menée dans le cadre de mon travail à l'OCDE (Organisation de Coopération et Développement Économique). J'ai ainsi bénéficié d'un encadrement à la fois par ma directrice de thèse, Florence Jusot, et par mon superviseur direct à l'OCDE, Franco Sassi. Les sujets traités dans cette thèse ont trouvé leur origine dans les projets menés à l'OCDE, et ont été approfondis dans le cadre d'un travail personnel ou en collaboration avec les co-auteurs des articles. Cette thèse utilise les données mises à disposition pour les projets OCDE. Les analyses, interprétations et opinions présentées dans cette thèse ne reflètent que celles des auteurs et n'engagent ni l'OCDE ni ses pays membres.

Je tiens à remercier tout d'abord chaleureusement ma directrice de thèse, Florence Jusot, pour m'avoir donné le goût de la recherche et encouragé dans cette voie, pour son encadrement tout au long de ce travail, et son écoute. Je remercie également Lise Rochaix et Fabrice Etilé pour avoir accepté d'être rapporteurs de cette thèse, ainsi que Thierry Lang et Jérôme Wittwer pour avoir accepté d'examiner ce travail.

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Enfin, mes pensées vont également pour Jean-Baptiste, ma famille et mes amis, pour leur soutien et leur écoute tout au long de ce travail.

Foreword

This thesis was carried out in parallel with my work at the OECD (Organisation for Economic Cooperation and Development). I was lucky to be supervised by both my PhD director, Florence Jusot, and my OECD supervisor, Franco Sassi. The topics developed in this thesis found their origin in OECD projects and were further explored as part of a personal work or in collaboration with the co-authors of the articles presented. This thesis uses data made available for OECD projects. The analyses, interpretations and views expressed in this thesis are those of the author and do not necessarily reflect those of the OECD or of the governments of its Member countries.

I would like first to warmly thank my PhD supervisor, Florence Jusot, for giving me the taste for research and for her encouragement in this direction, for her assistance throughout this work, and her responsiveness. I also would like to thank Lise Rochaix and Fabrice Etilé for accepting to be referees ("rapporteurs") of this thesis, and Thierry Lang and Jérôme Wittwer for agreeing to review this work.

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The course of this thesis was a rich process of exchange, advice and encouragement from my colleagues at the OECD. Special thanks to Caroline Berchet, Michele Cecchini, Emily Hewlett, Valerie Moran, and Lihan Wei; and I extend my heartfelt encouragement to those who are on their own paths to completing their PhDs.

Finally, my deep gratitude also goes to Jean-Baptiste, my family and friends for their support and attention throughout this work.

Résumé

Inégalités Sociales des Comportements de Santé:

L'herbe est-elle plus verte ailleurs?

Cette thèse traite des inégalités sociales en matière de comportements de santé tels que les modes de vie liés à la santé (spécifiquement, l'obésité et la consommation d'alcool) et l'utilisation des services de santé, dans plusieurs pays de l'OCDE. Ce travail repose sur une approche micro-économétrique et utilise un grand nombre de bases de données nationales. Les objectifs de cette thèse sont de: (1) comparer les inégalités sociales de comportements de santé entre des pays ayant des caractéristiques différentes, (2) apporter un éclairage à la compréhension des disparités sociales des comportements de santé, et enfin (3) examiner comment l'auto-déclaration dans les enquêtes peut affecter l'évaluation des comportements de santé, et donc affecter la mesure des inégalités.

Cette thèse se compose de six sections et repose sur quatre articles soumis ou publiés dans des journaux scientifiques. L'introduction générale offre un aperçu sur les inégalités de santé et s'intéresse aux déterminants des inégalités de santé et à la contribution des comparaisons internationales.

Le chapitre 1 présente les sources de données pour 23 pays de l'OCDE, les difficultés liées aux comparaisons multi-pays et les limitations des données d'enquête. Dans un deuxième temps, ce chapitre décrit les méthodes mises en œuvre pour mesurer les inégalités en comparaisons internationales.

Le chapitre 2 examine les inégalités sociales relatives à l'obésité et au surpoids selon le niveau d'éducation et le statut socio-économique dans 11 pays, et cette étude a été publiée dans le journal *European Journal of Public Health* en 2013. En outre, une série d'analyses portant sur cinq pays (Australie, Canada, France, Corée et Royaume-Uni) a été menée dans le but d'explorer la relation entre obésité et éducation. Ce travail a été publié dans le journal *OECD Economics Journal* en 2011.

Le chapitre 3 s'intéresse à la consommation d'alcool à risque selon le niveau d'éducation et le statut socio-économique dans 13 pays. L'analyse a pour objectif d'examiner les disparités sociales relatives à la consommation à risque telle que déclarée dans les enquêtes, et cherche à mesurer l'effet du biais d'auto-déclaration sur les inégalités sociales de consommation d'alcool. Ce papier a été soumis au journal *European Journal of Public Health* en 2014.

Le chapitre 4 traite des iniquités d'utilisation des services de santé dans 18 pays, et tente d'examiner le rôle des caractéristiques des systèmes de santé en tant que déterminants potentiels de ces iniquités. Les services de santé examinés sont les visites chez le médecin (généraliste et spécialiste), les visites chez le dentiste, et le dépistage de cancer du sein et du col de l'utérus. Cet article a été publié dans le journal *European Journal of Health Economics* en 2013.

Pour finir, la conclusion générale présente une discussion des principaux résultats, propose des recommandations pour la recherche et discute les implications politiques.

Summary

Social Inequalities in Health-Related Behaviours:

Is the grass greener on the other side?

This thesis deals with social inequalities in health-related behaviours such as lifestyle risk factors for health (precisely, obesity and alcohol consumption), and the utilisation of health care services, in a number of OECD countries. This work relies on a micro-econometrics approach, using a range of national health survey data. This thesis aims to (a) compare social inequalities in health-related behaviours across countries with different characteristics; (b) contribute to the understanding of social disparities in health-related behaviours; and (c) examine how self-reporting in surveys may affect the rating of behavioural risk factors, and therefore affect the measurement of social inequalities.

This thesis is composed of six sections and relies upon four articles submitted or published in peer-review journals. The general introduction provides some background on health inequalities with an emphasis on the role of the determinants of health inequalities and the contribution of international comparisons.

Chapter 1 presents the data sources used for 23 OECD countries, issues of cross-country comparability and survey data limitations. In a second step, it describes the methods applied to measuring inequalities in cross-country comparisons.

Chapter 2 examines inequalities in obesity and overweight by education level and by socioeconomic status in 11 countries, and was published in the *European Journal of Public Health* in 2013. In addition, a range of analyses conducted for Australia, Canada, France, England and Korea are undertaken with the aim of exploring the relationship between education and obesity. This work was published in the *OECD Economics Journal* in 2011.

Chapter 3 focuses on disparities in hazardous drinking across education levels and socioeconomic groups in 13 countries. The analysis aims to examine social disparities in risky alcohol consumption as reported in surveys, and assesses how self-report bias may affect social inequalities in drinking. This work was submitted to the *European Journal of Public Health* in 2014.

Chapter 4 investigates inequities in health care service utilisation in 18 countries, and tries to examine the role of health system features as potential determinants of these inequalities. The analysis focuses on doctor and dentist visits, and breast and cervical cancer screening. This study was published in the *European Journal of Health Economics* in 2013.

Finally, the general conclusion provides a discussion of the main findings, proposes recommendations for research, and discusses policy implications.

Résumé conséquent en français

Inégalités Sociales des Comportements de Santé:

L'herbe est-elle plus verte ailleurs?

Cette thèse traite des inégalités sociales en matière de comportements de santé tels que les modes de vie liés à la santé (spécifiquement, l'obésité et la consommation d'alcool) et l'utilisation des services de santé, dans plusieurs pays de l'OCDE. Ce travail repose sur une approche micro-économétrique et utilise un grand nombre de bases de données nationales. Les objectifs de cette thèse sont de: (1) comparer les inégalités sociales de comportements de santé entre des pays ayant des caractéristiques différentes, (2) apporter un éclairage à la compréhension des disparités sociales des comportements de santé, et enfin (3) examiner comment l'auto-déclaration dans les enquêtes peut affecter l'évaluation des comportements de santé, et donc affecter la mesure des inégalités.

1. Contexte

Les disparités d'état de santé (mesurées par la mortalité ou morbidité) ont largement été documentées dans la littérature internationale vis-à-vis du genre, l'ethnicité, l'origine sociale, l'éducation, le statut socio-économique et la zone géographique (van Doorslaer *et al.,* 1997 ; Mackenbach *et al.,* 2008 ; OCDE 2011). Les études sur les disparités de mortalité et de morbidité selon le statut socio-économique montrent notamment que les individus les plus défavorisés meurent prématurément comparé aux plus favorisés, et que les populations les plus pauvres, les plus vulnérables, sont plus affectées par les maladies. Eurostat (2010) a commencé à mesurer de façon régulière les disparités d'espérance de vie par niveau d'éducation dans les pays européens. Les dernières données montrent que l'écart d'espérance de vie à 30 ans selon le niveau de diplôme varie de 2,5 années chez les femmes en Slovénie à 17 années chez les hommes en Estonie.

Un grand nombre d'études se sont intéressées à comprendre les inégalités de santé et à explorer leurs déterminants (projet Eurothine, projet ECuity, van Doorslaer et Koolman, 2004 ; Cutler et Lleras-Muney, 2010). Durant les 10 dernières années, beaucoup d'attention a été portée aux déterminants de la santé, notamment avec la Commission des Déterminants Sociaux de la Santé de l'OMS initiée en 2005. Le travail mené par cette Commission a abouti à la publication d'un rapport en 2008 « *Closing the gap in a generation* », suivi de la déclaration politique de Rio en 2011 sur les déterminants sociaux de la santé, en faveur de plus d'efforts pour la réduction des inégalités de santé.

Les inégalités de santé sont un enjeu important pour les gouvernements pour deux raisons : elles sont injustes et engendrent des coûts sociaux. Tout d'abord, les inégalités de santé sont injustes parce qu'elles peuvent apparaître dès l'enfance et que chaque individu n'a pas les mêmes chances de bonne santé (Trannoy *et al.*, 2010). Les inégalités des chances liées aux circonstances dans l'enfance représentent 46% des inégalités sociales de santé (Jusot *et al.*, 2013). En outre, ces inégalités sont évitables puisqu'une meilleure définition des interventions politiques peut aider à les réduire (Woodward et Kawachi, 2000). Deuxièmement, les inégalités de santé peuvent avoir un impact sociétal plus large que les seuls résultats sur la santé, notamment en termes de bien-être global et de résultats sur le marché du travail, du fait qu'un mauvais état de santé est associé à une faible réussite scolaire et à de mauvais résultats sur le marché du travail. Mackenbach *et al.* (2010) estiment que les pertes sociales liées aux inégalités de santé atteignent 9,4% du PIB. Pour ces raisons, les gouvernements prêtent de plus en plus attention à la mesure et la compréhension des inégalités de santé, cherchant les moyens les plus appropriés pour les réduire.

2. Les déterminants des inégalités de santé

L'état de santé est influencé par de nombreux déterminants : caractéristiques génétiques, facteurs individuels et contextuels. Les facteurs individuels font référence aux conditions sociales et aux choix individuels, comme les conditions de vie et d'emploi, le niveau d'éducation, le statut socio-économique, l'intégration à la vie sociale, les comportements et modes de vie liés à la santé (comme la consommation de tabac et d'alcool, l'alimentation et l'activité physique), ainsi que la demande de soins de santé. Les facteurs contextuels font eux référence à de multiples dimensions environnantes comme la richesse nationale, les inégalités de revenu, les caractéristiques des systèmes de santé (ex. l'offre de soins, l'accès

gratuit aux soins, les politiques de prévention), les normes sociales, et les facteurs environnementaux (ex. transport et pollution). Tous ces déterminants ont un effet sur l'état de santé, et les interactions entre ceux-ci peuvent influencer l'état de santé plus ou moins fortement. La compréhension des inégalités de santé repose largement sur la compréhension des relations entre les facteurs socio-économiques, les comportements et la santé. Le cadre d'analyse de cette thèse propose d'étudier les inégalités sociales dans les modes de vie et dans l'utilisation des services de santé comme moyen de traiter les inégalités sociales de santé. Comme montré ci-dessous, ce cadre d'analyse est cohérent avec le modèle de Grossman et ses extensions.

2.1 Cadre théorique

Grossman (1972, 2000) a développé un cadre économique pour la demande de santé basé sur la théorie du capital humain. Dans ce modèle, la santé est un capital qui dépend d'un stock initial et se déprécie avec le temps, mais peut être augmenté avec un investissement en santé. Les individus sont des producteurs actifs de leur santé et cherchent à maximiser leur utilité en achetant des biens (ex. soins de santé, alimentation) et en combinant ceux-ci avec leur temps disponible. L'éducation accroît l'efficience de la production de santé car les individus les plus éduqués gèrent mieux l'information liée à la santé, et font de meilleurs investissements en santé. Le modèle de Grossman donne un cadre théorique pour la prédiction de la santé en fonction de l'éducation et du statut socio-économique, qui sont positivement reliés à l'investissement en santé. Ainsi, le modèle de Grossman est une base solide pour l'analyse des inégalités de santé (Galama et van Kippersluis, 2013).

L'investissement en santé étant un concept clé dans ce modèle, les modes de vie et les préférences individuelles jouent un rôle important dans ce cadre théorique. Plusieurs études confirment l'impact des modes de vie liés à la santé sur les inégalités sociales de santé (McGinnis et Foege, 1993 ; Contoyannis et Kones, 2004 ; Stringhini *et al.*, 2010). Cependant, les modes de vie à risque pour la santé peuvent contribuer à l'état de santé de différentes façons. Alors que la consommation de tabac contribue largement au gradient bien connu des inégalités sociales de santé, la consommation d'alcool peut parfois contraster. Van Kippersluis et Galama (2013) ont examiné pourquoi les plus riches boivent davantage et fument moins que les plus pauvres, et proposé une théorie sur les modes de vie expliquant pourquoi les plus riches s'engagent plus dans des comportements à risque modéré et moins dans des comportements à risque élevé pour la santé.

Dans le modèle de Grossman, l'éducation et le statut socio-économique sont corrélés à la santé. Cette corrélation a été largement validée dans les études empiriques. Cependant, l'existence d'une relation causale reste discutée. Le problème est d'identifier si le gradient social de santé reflète un lien causal du statut socio-économique vers la santé, ou une causalité inverse de la santé vers le statut socio-économique. Cette question a été étudiée dans la littérature et différents résultats émergent. Les conclusions des études vont dans les deux directions, montrant par exemple que la santé influence l'emploi (Morris, 2007 ; Lundborg *et al.*, 2010 ; Burton *et al.*, 1998) et que le travail influence la santé (Llena-Nozal, 2009 ; Robone *et al.*, 2011). À propos de cette dernière assertion, bien que l'impact du travail sur la santé apparaisse être positif dans certaines études et négatif dans d'autres, une certaine convergence des résultats suggère que l'effet négatif est lié à des situations où les employés n'ont pas de contrôle sur la quantité de travail à fournir (Bassanini et Caroli, 2014).

Une dimension importante relative à l'étude des inégalités de comportements de santé correspond aux préférences individuelles, à savoir si les individus donnent plus de valeur à une satisfaction immédiate plutôt qu'aux conséquences à long terme de leurs comportements de santé. En ce qui concerne les comportements addictifs liés à la santé, les individus doivent souvent faire un compromis entre la satisfaction immédiate résultant de la consommation de biens nocifs pour leur santé (ex. tabac, alcool, produits gras et sucrés) et une perte future de capital santé. Des modèles économiques pour les biens addictifs ont été développés à l'origine par Becker et Murphy (1988) introduisant la théorie de l'addiction rationnelle qui suppose que le consommateur est conscient des conséquences futures de sa consommation de biens addictifs et prend ces effets en compte en faisant ses choix. Ce modèle repose sur l'idée que les préférences actuelles pour les biens addictifs dépendent des consommations passées et futures de ces biens. Plusieurs études empiriques viennent confirmer la théorie de l'addiction rationnelle (Chaloupka et Warner, 2000 ; Clark et Etilé, 2002).

Les préférences individuelles sont corrélées à l'éducation et au statut socio-économique, mais il y a peu de résultats sur la direction de la causalité. Les individus ayant une préférence pour le futur investissent plus dans l'éducation et optent davantage pour des comportements bénéfiques pour la santé (Fuchs, 1982). De la même façon, les personnes les moins éduquées et les plus pauvres ont une préférence pour le présent plus marquée que les personnes les plus aisées (Becker et Mulligan, 1997). La connexion entre préférences individuelles, comportements de santé, et éducation a donc toute son importance dans l'étude des inégalités sociales des comportements de santé. Les préférences

individuelles peuvent affecter les relations entre éducation et santé en jouant un rôle de médiation des inégalités sociales de santé comme le suggère la littérature (van de Pol, 2011 ; Jusot et Khlat, 2013).

2.2 Les inégalités sociales dans les comportements de santé

Le cadre d'analyse de cette thèse propose d'étudier les inégalités sociales relatives aux modes de vie et à l'utilisation des services de santé comme moyen de traiter les inégalités sociales de santé. En effet, réduire les inégalités dans les modes de vie et dans l'utilisation des services de santé peut aider à lutter contre les inégalités sociales de santé en général.

Les différences sociales de mortalité et de morbidité peuvent être directement liées aux conditions de vie (ex. profession ayant un risque inhérent de cancer), mais elles peuvent aussi émerger de différences de modes de vie ou de différences de recours aux soins entre groupes sociaux. Les modes de vie jouent un rôle important dans le lien entre santé et facteurs socio-économiques. Ils sont souvent influencés par l'éducation et le statut socio-économique ; et en même temps, ils contribuent au développement de maladies chroniques (ex. maladies cardiovasculaires, diabète, cancers, santé mentale, maladies musculo-squelettiques) et affectent ainsi la santé et la longévité. De même, l'accès aux soins est tout aussi important dans le processus de détermination des inégalités de santé. Par exemple, les personnes à hauts revenus ont un meilleur accès aux services de santé, ce qui se traduit par des différences de résultats de santé liées au niveau de revenus.

Ainsi, réduire les inégalités sociales de santé relève non seulement d'efforts pour améliorer les résultats de santé des populations les plus défavorisées, mais aussi d'efforts pour réduire les inégalités dans les modes de vie et dans l'utilisation des services de santé. Outre les comportements liés à la santé, des facteurs externes peuvent interagir. On pense notamment aux facteurs contextuels et environnementaux tels que les caractéristiques des systèmes de santé (ex. densité des services médicaux, systèmes de paiement), normes sociales, transport et pollution.

3. L'apport des comparaisons internationales

3.1 L'importance des comparaisons internationales

Cette thèse s'intéresse à la mesure et à la comparaison des inégalités sociales des comportements de santé, avec pour objectif d'avoir une utilisation appropriée des analyses multi-pays. Les études internationales permettent aux décideurs politiques d'apprendre des pays voisins les bonnes pratiques et de comprendre l'impact des politiques, bien que cela ne soit pas sans difficultés.

Les études internationales peuvent aider les pays à développer leur connaissance et leur compréhension, et elles favorisent l'introspection et permettent des changements dans la manière de penser et d'identifier les problèmes. Les évaluations multi-pays permettent de dresser un tableau précis de la situation et d'identifier où sont les problèmes, comment les autres pays gèrent ceux-ci, quels pays réussissent mieux, pourquoi et comment. Les comparaisons internationales offrent aussi une base pour l'analyse des relations entre performance des pays et politiques, et plus précisément, elles offrent une source de connaissance et des preuves pour une meilleure compréhension de l'impact des politiques publiques. Cependant, ce travail s'accompagne bien souvent de difficultés. En effet, des problèmes conceptuels et pratiques peuvent émerger comme par exemple des problèmes liés à la disponibilité et à la comparabilité des données, ou encore aux différences dans les caractéristiques institutionnelles des pays.

Cette thèse s'intéresse aux aspects analytiques et méthodologiques de l'évaluation entre pays plutôt qu'aux comparaisons des politiques. Ce travail n'essaye pas de répertorier les politiques nationales en place ou de proposer un ensemble de bonnes pratiques. En revanche, il a pour but de dresser un tableau précis des inégalités entre pays, en collectant des données d'enquêtes nationales, rendant les données homogènes entre pays, et développant des mesures comparables. De plus, cette thèse soulève des questions méthodologiques et des questions autour de l'interprétation des résultats afin d'améliorer les recommandations en termes de politiques.

3.2 Étude des inégalités de santé entre pays

Il existe deux initiatives au niveau européen, initiées dans les années 1990, qui ont pour but de mesurer et de comprendre les inégalités de santé (Jusot, 2010). Financés par la Commission Européenne, ces deux projets mettent en lumière l'existence d'inégalités de santé et de grandes variations entre pays. Ces projets s'intéressent aussi aux inégalités relatives aux modes de vie et à l'utilisation des services de santé.

Tout d'abord, le programme de recherche du groupe de travail de l'Union Européenne sur « *Socioeconomic Inequalities in Health* », suivi du projet Eurothine (*Tackling Health Inequality in Europe*) mené par Johan Mackenbach et Anton Kunst, ont montré l'existence de fortes inégalités de santé dans l'Union Européenne dans les années 1990, et d'importantes variations de l'amplitude de ces inégalités, suggérant qu'une réduction des inégalités de santé est possible. Dans la lignée de ces recherches, le projet Européen EURO-GBD-SE a récemment identifié les points d'entrée les plus importants pour les politiques visant à réduire les inégalités de santé.

Deuxièmement, le projet ECuity dirigé par Eddy van Doorslaer, Adam Wagstaff et Andrew Jones, initié au début des années 1990, a apporté d'importantes avancées méthodologiques et a contribué aux dimensions suivantes : iniquité dans le financement de la santé, iniquité dans l'offre de soins, iniquité dans l'utilisation des services de santé, et inégalités d'état de santé. L'actuel projet ECuity III s'intéresse en outre aux déterminants de la demande de soins de santé et aux relations causales (ex. impact des inégalités de revenu, de l'assurance privée, des restes à charge des patients) pour mieux aider à la décision politique.

Une extension du travail ECuity aux pays de l'OCDE a permis de couvrir un plus large éventail de pays (van Doorslaer et Masseria, 2004). Cette étude portant sur les iniquités d'utilisation des soins de santé par niveau de revenus, a couvert 21 pays de l'OCDE (un grand nombre de pays européens ainsi que l'Australie, le Canada, le Mexique, et les USA). Ce projet a mis en lumière des iniquités en faveur des plus pauvres pour les visites de médecins généralistes, et en faveur des plus riches pour les visites de spécialistes, dans plusieurs pays.

Enfin, il est important de souligner que ces projets ne pourraient exister sans les efforts mis en œuvre pour développer des données d'enquête harmonisées au niveau Européen (ex. enquête ECHP *European Community Household Panel*, EHIS *European Health Interview Survey*, SHARE *Survey of Health and Retirement in Europe*). Alors que les gouvernements prêtent davantage attention aux inégalités de santé, des efforts techniques sont constamment développés au niveau international pour contrôler et comprendre ces inégalités. Par exemple, Eurostat inclut depuis peu un nouvel indicateur sur les différences d'espérance de vie par niveau d'éducation afin de permettre le suivi des inégalités de santé.

Ces travaux sur la mesure et la compréhension des inégalités de santé et sur les pistes possibles pour les réduire ouvrent de nouvelles voies de recherche. Par exemple, l'inclusion de pays non-Européens

dans les comparaisons internationales apparaît nécessaire. De plus, les champs de la statistique et de l'économétrie ne cessent de se développer et de nouvelles techniques peuvent améliorer les recherches précédentes. De nouveaux développements sur la mesure des inégalités permettent d'améliorer l'évaluation dans le cadre de comparaisons multi-pays. Par exemple, lorsqu'on analyse les inégalités sociales de santé en comparaison internationale, il est essentiel d'utiliser des outils appropriés pour comparer les inégalités entre pays ayant des caractéristiques différentes (ex. structure de la population, distribution du niveau d'éducation et de la classe sociale). Des mesures agrégées des inégalités telles que l'indice de concentration et les indices relatifs et absolus d'inégalité ainsi que leurs récentes extensions, sont utilisés pour faire face à ce problème.

3.3 Études multi-pays sur les inégalités de comportements de santé

Ce travail est par ailleurs motivé par le besoin d'une connaissance approfondie de l'étendue des inégalités des comportements de santé dans un contexte international, et ceci dans le but de développer les instruments politiques efficaces visant les modes de vie. Il existe assez peu d'études sur les disparités sociales des comportements de santé en comparaison internationale. Bien que les inégalités de santé aient été largement explorées pour un grand nombre de variables de santé, assez peu d'études se sont focalisées sur les comportements à risque. Une des raisons principales est que les modes de vie sont difficiles à mesurer, leur mesure étant entachée d'erreur et de biais de déclaration. Par exemple, les mesures de l'indice de masse corporelle et d'obésité peuvent être sujettes à des inexactitudes dues à une déclaration erronées du poids et de la taille. De même, les mesures de consommation d'alcool peuvent souffrir de biais d'auto-déclaration avec une forte sous-estimation de la quantité d'alcool consommée. Néanmoins, la littérature dénombre un nombre croissant d'études s'intéressant aux inégalités sociales relatives à l'obésité (Mackenbach *et al.*, 2008; Costa-Font *et al.* 2013), à l'alimentation et à l'activité physique (Gordon-Larsen *et al.*, 2006; Filippidis *et al.*, 2014), à la consommation de tabac (Cavelaars *et al.*, 2000; Mackenbach *et al.*, 2008), mais très peu d'études relatives à la consommation d'alcool.

En outre, le problème de l'auto-déclaration soulève la question de savoir si le biais de déclaration affecterait l'appréciation des comportements individuels, et le cas échéant, si ce biais varierait selon le groupe socio-économique et par conséquent affecterait les mesures des inégalités sociales. Quelques études s'intéressent aux biais de déclaration et à la mesure des inégalités relatives à l'obésité (Cawley, 2000; Lakdawalla et Philipson, 2002; Ljungvall *et al*. 2012; Costa-Font *et al.,* 2014). En particulier, Ljungvall *et al.* (2012) montrent à partir de données suisses que les disparités sociales relatives à l'obésité sont

affectées par un biais de déclaration chez les femmes mais pas chez les hommes. Costa-Font *et al.* (2014) confirment ce résultat sur données espagnoles montrant que les inégalités d'obésité sont plus marquées après correction du biais de déclaration, notamment chez les femmes. Cependant, à ma connaissance, il n'y a pas de recherche publiée sur l'effet des biais de déclaration sur les inégalités sociales dans la consommation d'alcool.

L'étude sur l'accès aux soins vient compléter l'analyse des inégalités des modes de vie. La section précédente a montré que les inégalités de mortalité et de morbidité pouvaient résulter d'inégalités relatives aux modes de vie et à l'utilisation des services de santé. Des études antérieures menées autour des années 2000 ont montré que dans un grand nombre de pays les individus à hauts revenus avaient plus de chance de consulter un médecin (en particulier, un spécialiste et un dentiste) et de faire un dépistage de cancer que les individus à bas revenus, ceci étant vrai pour un même niveau de besoin de soins de santé (van Doorslaer et Masseria, 2004; Or *et al.,* 2008; Bago d'Uva *et al.,* 2009). Néanmoins, depuis 2000, certaines réformes ont été mises en place dans le but de réduire les inégalités d'accès aux soins (ex. système de gatekeeping, réduction de copaiement, programme de dépistage gratuit). Ainsi est-il nécessaire de réévaluer les inégalités d'utilisation des services de santé et d'analyser ces inégalités en lien avec les caractéristiques des systèmes de santé. Dans le but d'éclairer la décision politique, il apparaît en effet intéressant d'identifier quelles caractéristiques des systèmes de santé sont associées à un faible degré d'inégalité.

4. L'apport de cette thèse

4.1 Questions de recherche

À travers l'objectif général d'examiner les inégalités sociales des comportements de santé dans différents pays, cette thèse cherche à répondre à trois questions de recherche portant sur des aspects méthodologiques et sur les implications politiques des inégalités sociales des comportements de santé. Ces trois questions de recherche sont les suivantes :

- Comment peut-on comparer les inégalités sociales de santé entre pays ayant des caractéristiques différentes (par ex. structure de la population, distribution du niveau d'éducation et du statut socio-économique) ?

- Au-delà de l'observation et du contrôle des disparités sociales de santé, quel éclairage peut-on apporter sur la compréhension de ces inégalités ? Et, comment mieux informer les décideurs politiques ?
- Comment le biais de déclaration affecte-il l'évaluation des comportements de santé? Est-ce que le biais de déclaration varie selon les groupes sociaux et affecte par conséquent la mesure des inégalités sociales?

4.2 Les principaux résultats

Cette thèse traite des inégalités sociales relatives aux modes de vie et à l'utilisation des services de santé. Elle repose sur une approche micro-économétrique et utilise un grand nombre d'enquêtes nationales. Elle se compose de quatre chapitres. Le premier chapitre présente les données et méthodes employées dans les différentes analyses. Les deuxième et troisième chapitres s'intéressent aux modes de vie (l'obésité et le surpoids dans le chapitre 2 et la consommation d'alcool dans le chapitre 3). Le quatrième chapitre examine les inégalités d'utilisation des services de santé liées aux revenus. Enfin, la conclusion générale offre une discussion des principaux résultats, propose des recommandations pour la recherche et discute les implications politiques.

Le chapitre 1 présente les données et méthodes utilisées dans cette thèse. Les données issues d'enquêtes de santé ont été collectées pour 23 pays de l'OCDE. Les mesures de l'obésité, du surpoids et de la consommation d'alcool sont décrites et leur validité remise en question. La réflexion est notamment portée sur un possible biais d'auto-déclaration des comportements à risque dans les enquêtes de santé et l'effet de ce biais sur la mesure des inégalités. Ce chapitre présente aussi les méthodes employées pour évaluer les inégalités telles que les indices absolus et relatifs d'inégalité et l'indice de concentration.

Le chapitre 2 examine le gradient social d'obésité (et de surpoids) dans 11 pays de l'OCDE. Ce travail, co-écrit avec Franco Sassi, a été publié dans le journal *European Journal of Public Health* en 2013. Les inégalités d'obésité liées au niveau d'éducation et au statut socio-économique sont mesurées à l'aide des indices absolus et relatifs d'inégalité. Les résultats montrent que les indices absolus et relatifs d'inégalité capturent des dimensions différentes et peuvent conduire à des classements de pays différents. Par exemple, pour les inégalités liées au niveau d'éducation, les inégalités absolues sont plus larges en Hongrie et en Espagne pour les hommes et les femmes, alors que les inégalités relatives sont

plus larges en France et en Suède pour les hommes et en Espagne et en Corée pour les femmes. De plus, cette étude montre que les inégalités sociales d'obésité sont plus marquées chez les femmes que chez les hommes. Cette différence de genre dans les disparités sociales d'obésité a une grande importance puisque les femmes ayant un faible niveau d'éducation et un faible statut socio-économique ont plus de chance d'être obèses et de donner naissance et d'élever des enfants obèses, perpétuant alors le cercle vicieux des inégalités sociales. Ainsi, en termes de recommandations politiques, cette analyse est-elle en faveur d'un ciblage des groupes de population à risque tels que les femmes ayant un faible niveau d'éducation et un faible statut socio-économique.

En outre, le chapitre 2 présente une analyse de la relation entre éducation et obésité menée sur cinq pays (Angleterre, Australie, Canada, Corée, et France). Cette étude co-écrite avec Franco Sassi, Jody Church, Michele Cecchini et Francesca Borgonovi, a été publiée dans le journal *OECD Economics Journal* en 2011. Une relation quasi linéaire est mise en évidence entre le nombre d'années d'éducation et la probabilité d'obésité. Ce résultat suggère qu'une année supplémentaire d'éducation à quelque niveau que ce soit conduirait à réduire le risque d'obésité dans une proportion similaire, si le lien de causalité de l'éducation vers l'obésité était confirmé. Cependant, le lien de causalité entre éducation et obésité n'a pas été démontré avec certitude. Une analyse sur données françaises montre que l'association entre éducation et obésité n'est que faiblement affectée lorsqu'on tient compte des opportunités réduites d'éducation pour les individus obèses aux âges jeunes. Ce résultat suggère ainsi que la causalité prédomine dans le sens éducation vers obésité. De plus, l'analyse des effets de médiation via la position socio-économique de l'individu et l'analyse des effets de concurrence via le niveau d'éducation de la mère montrent que l'éducation affecte l'obésité essentiellement de manière directe. Enfin, les résultats mettent en évidence non seulement un effet absolu de l'éducation sur l'obésité, mais aussi un effet relatif, c'est-à-dire que le niveau d'éducation de l'individu relativement à celui de ses pairs a une influence sur l'obésité. En termes de recommandations politiques, cet article encourage davantage d'investissement dans l'éducation pour aider à réduire l'obésité, via des programmes favorisant l'allongement de la scolarisation et des programmes d'éducation à la santé, notamment en direction des individus défavorisés et quittant prématurément le système scolaire.

Le chapitre 3 s'intéresse à la consommation d'alcool à risque selon le niveau d'éducation et le groupe socio-économique. Ce papier, co-écrit avec Franco Sassi, a été soumis au journal *European Journal of Public Health* en 2014. L'analyse couvre 13 pays de l'OCDE, et examine les disparités sociales relatives à la consommation à risque telle que déclarée dans les enquêtes de santé. De plus, ce papier cherche à

mesurer l'effet du biais d'auto-déclaration sur les inégalités sociales en corrigeant la distribution de consommation d'alcool par des données agrégées sur les ventes d'alcool. Les résultats montrent que les disparités sociales varient selon le genre. Les femmes les plus éduquées ont plus de chance d'adopter une consommation à risque que les femmes les moins éduquées, alors qu'une relation inverse est observée chez les hommes dans la plupart des pays étudiés. Les estimations de la consommation d'alcool basées sur les données d'enquête et celles issues de données agrégées de vente présentent de grandes différences. L'analyse révèle une erreur d'estimation du gradient social due au biais d'auto-déclaration dans les enquêtes de consommation d'alcool. Après correction du biais d'auto-déclaration, on trouve de plus fortes inégalités sociales chez les femmes, et de plus faibles inégalités -parfois même avec une inversion du gradient social- chez les hommes. Ainsi cet article est-il non seulement en faveur de politiques ciblées vers les groupes de population les plus à risque, mais il appelle aussi à davantage d'efforts sur les méthodologies d'enquête pour améliorer la mesure et le contrôle de la consommation à risque au niveau individuel.

Le chapitre 4 traite des iniquités d'utilisation des services de santé dans 18 pays de l'OCDE, et tente d'examiner le rôle des caractéristiques institutionnelles nationales en tant que déterminants potentiels de ces iniquités. Cet article a été publié dans le journal *European Journal of Health Economics* en 2013. Les services de santé examinés sont les suivants : les visites chez le médecin (généraliste et spécialiste), les visites chez le dentiste, et le dépistage de cancer. Le degré des inégalités est mesuré à l'aide d'un indice de concentration corrigé pour tenir compte des variations de la prévalence de la variable de santé étudiée entre pays. Les résultats montrent des iniquités en faveur des plus riches pour les visites chez un médecin (iniquité fortement marquée pour les visites de spécialistes), ainsi que pour les visites de dentiste et de dépistage de cancer. Bien que l'analyse des corrélations avec les caractéristiques institutionnelles nationales ait été limitée par les données, cet examen a permis d'apporter un éclairage intéressant. On observe notamment que les pays qui présentent de plus larges iniquités sont ceux n'ayant pas de couverture universelle de santé, ceux où le financement de la santé repose largement sur l'assurance privée et les paiements directs des usagers, où les généralistes n'ont pas un rôle de coordinateur de soins, où l'offre de soins est essentiellement privée, et où l'avance de frais lors des visites médicales est obligatoire. En termes d'implications politiques, cet article montre que malgré les objectifs nationaux d'équité d'accès aux soins, des iniquités selon le niveau de revenus persistent. Les résultats suggèrent des pistes possibles quant aux réformes institutionnelles pouvant favoriser l'équité d'accès aux soins, et suggèrent qu'un contrôle continu des iniquités d'utilisation des services de santé est essentiel pour évaluer le succès des politiques futures.

5. Recommandations pour la recherche et implications politiques

Les résultats présentés dans cette thèse ont d'importantes implications politiques et conduisent à formuler des recommandations pour la recherche. Deux principales recommandations pour la recherche peuvent être tirées de ce travail. Tout d'abord, cette thèse met en évidence de nombreuses limitations vis-à-vis de l'harmonisation des données et de la disponibilité des données. Des améliorations seraient nécessaires sur deux plans : (a) harmoniser les questions d'enquêtes dans le but de faciliter les comparaisons internationales, et (b) rendre les données disponibles aux chercheurs dans les délais plus courts. Ensuite, au-delà de la mesure et du contrôle des inégalités de santé, il semble nécessaire de porter plus d'efforts à la compréhension de ces inégalités pour aider à la définition de politiques plus efficaces pour réduire ces inégalités (ex. identifier l'impact causal des déterminants des inégalités).

En ce qui concerne les implications pour les politiques publiques, les résultats de cette thèse mettent en évidence des leviers d'action possibles pour aider à lutter contre les inégalités sociales de comportements de santé, et plus généralement réduire les inégalités sociales de santé. Tout d'abord, cette thèse suggère que pour des mesures politiques efficaces, il est important de cibler les groupes de population les plus à risque, en particulier les individus ayant un plus faible niveau d'éducation et un faible statut socio-économique qui concentrent une plus forte prévalence de facteurs de risque, et les individus à bas revenus qui ont davantage de barrières d'accès aux soins. Des politiques de redistribution mieux ciblées (ex. transferts monétaires, filets de protection sociale) combinées à des politiques de santé visant les plus défavorisés (ex. programmes ciblés d'éducation à la santé et de prévention) peuvent aider à réduire les inégalités de comportements de santé.

Deuxièmement, comme exposé dans cette thèse, la santé et les inégalités de santé sont liées à de nombreuses autres dimensions telles que l'éducation, l'emploi et le revenu. D'un point de vue politique, il apparaît donc intéressant de prendre en considération ces relations multisectorielles et de concevoir la politique de santé au centre d'un agenda politique plus large. On peut penser par exemple à inclure des objectifs de santé dans les autres secteurs politiques (ex. éducation, emploi et affaires sociales). Par exemple, au Japon, un programme de prévention des maladies chroniques est actuellement mis en place sur le lieu de travail dans le but de maintenir les employés plus longtemps en activité et en bonne santé, afin d'améliorer la productivité au travail. Bien entendu, de telles initiatives impliquent de mettre en

place une coordination entre les ministères et, en particulier, de s'entendre sur les modalités de financement (ex. qui paie ? qui perçoit les bénéfices ?).

Troisièmement, le cadre d'analyse de cette thèse suppose que l'objectif de réduction des inégalités sociales est réalisable dans une certaine mesure en se concentrant sur les inégalités de comportements de santé. En particulier, les modes de vie tels que l'obésité et la consommation de tabac et d'alcool, peuvent être directement ciblés par les gouvernements pour améliorer les résultats de santé. Les gouvernements peuvent en effet réduire les facteurs de risque liés aux modes de vie par le biais de politiques cherchant à cibler les comportements à risque pour la santé, telles que les politiques de promotion de la santé ou politiques de régulation. À propos des politiques de promotion de la santé visant à réduire l'obésité, des programmes nationaux coordonnés (comprenant des campagnes dans les médias de masse et des interventions à l'école) sont de plus en plus utilisés par les pays, comme aux États-Unis (*Let's move*), au Royaume-Uni (*Change4Life*) et même parmi les états membres de l'UE avec le plan d'action européen 2014 de réduction de l'obésité infantile. Au-delà du seul rôle des gouvernements, l'implication d'autres parties prenantes comme l'industrie du tabac, de l'alcool et agro-alimentaire, la communauté, et les associations de médecins et de patients, semble promettre de meilleurs résultats. Par exemple, l'industrie agro-alimentaire peut jouer un rôle dans la lutte contre l'obésité en reformulant le contenu des produits, c'est le cas par exemple en Hongrie après l'implémentation de la taxe sur les produits gras et sucrés, et aux Pays-Bas après l'instauration de l'étiquetage nutritionnel obligatoire.

À propos des politiques de régulation, les gouvernements peuvent employer des mesures de taxations, régulation de la publicité, et restrictions géographiques et horaires (pour le tabac et l'alcool). Par exemple, pour contrer l'obésité, la France, la Hongrie et le Mexique ont mis en place une taxe sur les boissons sucrées. Une inquiétude vis-à-vis des mesures de taxation relève de leur impact régressif sur les individus à bas revenus. Cependant, des analyses ont montré que les individus ayant un faible statut socio-économique bénéficient davantage des politiques de prévention en termes de résultats de santé puisque ces individus ont une plus forte prévalence de facteurs de risque (Sassi *et al.*, 2009). En outre, pour contrebalancer l'effet négatif des taxes, des mesures redistributives peuvent être mises en place. Par exemple, les sommes collectées grâce aux taxes pourraient servir à financer des bons d'achat pour des produits sains ou des paniers de fruits et légumes à l'intention des individus à bas revenus, défavorablement affectés par l'introduction de telles taxes.

6. Prolongements possibles de ce travail

Les analyses présentées dans cette thèse ouvrent de nouvelles pistes de recherche et soulèvent des questions qui pourraient être étudiées dans des investigations futures. Quatre pistes de recherche peuvent ainsi être proposées.

Tout d'abord, l'analyse de la relation entre éducation et obésité offre un éclairage sur la nature du lien et tente d'évaluer le sens de la causalité. Cependant, l'investigation du lien causal est limitée du fait des données transversales dont nous disposions à ce moment-là, alors que des données longitudinales auraient été plus appropriées. Afin de mener des explorations plus poussées, il serait intéressant d'analyser le lien causal sur données longitudinales comme par exemple celles du *British Household Panel Survey* ou de l'enquête *Household, Income and Labour Dynamics in Australia*.

Deuxièmement, l'étude sur les inégalités de consommation à risque d'alcool met en évidence d'importantes limitations sur les données d'enquête quant à la mesure de la consommation d'alcool. La consommation d'alcool apparaît largement sous-estimée dans les données d'enquête. Alors que les données d'enquête ont été corrigées du biais d'auto-déclaration en utilisant des données agrégées de vente d'alcool, une nouvelle technique de correction a été récemment avancée (utilisant deux types de questions dans les enquêtes, l'une sur la quantité-fréquence de consommation et l'autre sur la consommation la veille de l'enquête) (Meier *et al.*, 2013; Stockwell *et al.*, 2014). De nouvelles analyses utilisant cette méthode de correction pourrait chercher à confirmer l'existence d'une erreur d'estimation des inégalités de consommation à risque d'alcool due au biais d'auto-déclaration dans les enquêtes.

Troisièmement, l'étude sur l'utilisation des services de santé cherchent à apporter un éclairage sur le rôle des caractéristiques institutionnelles nationales. Néanmoins, l'analyse est fortement limitée par le faible nombre de pays étudiés, et donc, par le manque de variabilité au niveau pays. De nouvelles analyses plus robustes (utilisant des modèles multiniveaux) pourraient être menées à condition d'accéder à des bases de données adéquates permettant d'accroître le nombre des pays étudiés.

Quatrièmement, alors que l'étude sur l'utilisation des services de santé met en évidence des iniquités persistantes, il serait intéressant d'examiner l'effet de la crise économique de 2008 sur l'utilisation des services de santé et d'évaluer dans quelle mesure la crise aurait contribué à accroître les inégalités sociales d'accès aux soins. Une étude récente montre que la crise a conduit à détériorer l'accès

aux soins bien que les effets varient entre pays européens (Eurofound, 2013). De même les dernières données européennes de l'enquête EU-SILC 2012 indiquent une augmentation du non-recours aux services de santé suite à la crise parmi les plus défavorisés (OCDE, 2014). Dans les mois à venir, alors que de nouvelles données seront mises à disposition des chercheurs, il serait intéressant d'évaluer l'impact de la crise sur l'utilisation des services de santé et sur la santé elle-même selon le statut socio-économique.

REFERENCES

Bago d'Uva T, Jones AM, van Doorslaer E. (2009). "Measurement of Horizontal Inequity in Health care Utilisation Using European Panel Data". *Journal of Health Economics*, 28 :280-289.

Bassanini A, Caroli E. (2014), "Is Work Bad for Health? The Role of Constraint vs Choice". *IZA Discussion Paper No. 7891*.

Becker GS and Mulligan CB. (1997), "The endogenous determination of time preference". *Quarterly Journal of Economics*, 112:729–758.

Becker GS and Murphy KM. (1988), "A Theory of Rational Addiction". *Journal of Political Economy*, 96(4):675-700.

Burton WN, Chen CY, Schultz AB and Edington DW. (1998), "The Economic Costs Associated with Body Mass Index in a Workplace", *J. Occup. Env. Med*., 40(9):786-792 .

Cavelaars A, Kunst A, Geurts J, Crialesi R, Grotvedt L, Helmert U, Lahelma E, Lundberg O, Matheson J, Mielck A, Rasmussen N Kr, Regidor E, do Rosario-Giraldes M, Spuhler Th, Mackenbach J. (2000), "Educational differences in smoking: international comparison". *BMJ*, 320:1102–7.

Cawley J. (2000), "Body Weight and Women's Labor Market Outcomes", Cambridge, MA, National Bureau of Economic Research, Working Paper No. 7841.

Chaloupka FJ and Warner KE. (2000), "The Economics of Smoking", in A.J. Culyer and J.P. Newhouse (eds.), Handbook of Health Economics, Oxford, North Holland.

Clark A and Etilé F. (2002), "Do health changes affect smoking? Evidence from British panel data". *Journal of Health Economics*, 21(4):533-562.

Contoyannis P, Jones A. (2004), "Socio-economic status, health and lifestyle". *Journal of Health Economics*, 23: 965-995.

Costa-Font J, Hernandez-Quevedo C, Jimenez-Rubio D. (2014), "Income inequalities in unhealthy life styles in England and Spain". *Economics and Human Biology*, 13:66–75.

Cutler D, Lleras-Muney A. (2010), "Understanding differences in health behaviors by education". *Journal of Health Economics*, 29: 1–28.

ECuity project, website available at: http://www2.eur.nl/bmg/ecuity/

Eurofound (2013), *Impacts of the crisis on access to healthcare services in the EU*, Dublin.

Eurostat (2010), "Highly educated men and women likely to live longer". Available at: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-10-024/EN/KS-SF-10-024-EN.PDF

Eurothine project, website available at http://www.euro-gbd-se.eu/

Filippidis FT, Schoretsaniti S, Dimitrakaki C, Vardavas CI, Behrakis P, Connolly GN, Tountas Y. (2014), "Trends in cardiovascular risk factors in Greece before and during the financial crisis: the impact of social disparities". *European Journal of Public Health*. doi: 10.1093/eurpub/cku028

Fuchs VR. (1982), "Time preference and health: An exploratory study". In VR Fuchs (eds), Economic aspects of health. Chicago: University of Chicago Press. 93–120.

Galama T and Van Kippersluis H. (2013), "Health Inequalities through the Lens of Health Capital Theory: Issues, Solutions, and Future Directions". Tinbergen Institute Working paper No. 13-076/V.

Gordon-Larsen P, Nelson MC, Page P, Popkin BM. (2006), "Inequality in the Built Environment Underlies Key Health Disparities in Physical Activity and Obesity". *Pediatrics*, 117(2):417-424.

Grossman M. (1972), "On the concept of health capital and the demand for health". *The Journal of Political Economy,* 80(2), 223-255.

Grossman M. (2000). "The Human Capital Model", in Culyer A.J., Newhouse J.P. (eds), Handbooks of Health Economics, Elsevier: 348-408.

Jusot F (2010) "Les interventions de réduction des inégalités sociales de santé en Europe" in Réduire les inégalités sociales en santé, L. Potvin, M-J Moquet et C. M. Jones (sous la dir.), Inpes, pp.73-88.

Jusot F, and Khlat M. (2013), "The role of time and risk preferences in smoking inequalities: A population-based study". *Addictive Behaviors*, 38:2167–2173.

Jusot F, Tubeuf S, Trannoy A. (2013), "Les différences d'état de santé en France: inégalités des chances ou reflet des comportements à risques? " *Économie et Statistique*, 455-456.

Lakdawalla D, and Philipson T. (2002), "The Growth of Obesity and Technological Change: A Theoretical and Empirical Examination". Working Paper 8946, http://www.nber.org/papers/w8946

Ljungvall Å, Gerdtham U-G, Lindblad U. (2012), "Misreporting and misclassification: implications for socioeconomic disparities in body-mass index and obesity". Lund University Working paper 19. http://project.nek.lu.se/publications/workpap/papers/WP12_19.pdf

Llena-Nozal A. (2009), "The effect of work status and working conditions on mental health in four OECD countries", *National Institute Economic Review*, 209(1):72-87.

Lundborg P, Nystedt P and Rooth D. (2010), "No Country for Fat Men? Obesity, Earnings, Skills, and Health among 450,000 Swedish Men". *IZA Discussion Paper No. 4775*, www.ed.lu.se/papers/iza_lundborg.pdf.

Mackenbach JP, Meerding WJ, Kunst AE, (2011), "Economic costs of health inequalities in the European Union". *J Epidemiol Community Health,* 65:412-419.

Mackenbach JP, Stirbu I, Roskam AR, Schaap MM, Menvielle G, Leinsalu M et al. (2008), "Socioeconomic Inequalities in Health in 22 European Countries". *The New England Journal of Medicine*, 358: 2468-2481.

McGinnis J, Foege WH. (1993), "Actual causes of death in the United States". *Journal of the American Medical Association*, 270, 2207–2212.

Meier PS, Meng Y, Holmes J, Baumberg B, Purshouse R, Hill-McManus D, et al., (2013), "Adjusting for unrecorded consumption in survey and per capita sales data: Quantification of impact on gender- and age-specific alcohol-attributable fractions for oral and pharyngeal cancers in Great Britain". *Alcohol and Alcoholism*, 48(2): 241-249.

Morris S. (2007), "The Impact of Obesity on Employment", *Labour Economics*, 14:413-433.

OECD (2011), How's Life? Measuring Well-Being. OECD, Paris; 2011.

OECD (2014), *Health at a Glance Europe*, Paris.

Or Z, Jusot F, Yilmaz E. (2008). "Impact of Health care System on Socioeconomic Inequalities in Doctor Use". *IRDES Working Paper No.17.* IRDES, Paris.

Robone S, Jones A and Rice N. (2011), "Contractual conditions, working conditions and their impact on health and well-being", *European Journal of Health Economics*, 12(5):429-444.

Sassi F, Cecchini M, Lauer J, and Chisholm D. (2009), "Improving Lifestyles, Tackling Obesity: The Health and Economic Impact of Prevention Strategies". *OECD Health Working Paper 48*.

Stockwell T, Zhao J, and Macdonald S. (2014), "Who under-reports their alcohol consumption in telephone surveys and by how much? An application of the 'yesterday method' in a national Canadian substance use survey". *Addiction*, doi:10.1111/add.12609.

Stringhini S, Sabia S, Shipley M, Brunner E, Nabi H, Kivimaki M, Singh-Manoux A. (2010), "Association of socioeconomic position with health behaviors and mortality. The Whitehall II study". *JAMA*, 303(12): 1159–1166.

Trannoy A, Tubeuf S, Jusot F and Devaux M, (2010), "Inequality of Opportunities in Health in France : a first pass". *Health Economics*, 19(8):921-38.

Van der Pol M. (2011), "Health, Education and Time Preference". *Health Economics*, 20:917-929.

van Doorslaer E, and Koolman X. (2004), "Explaining the differences in income-related health inequalities across European countries", *Health Economics*, 13: 609–628.

van Doorslaer E, and Masseria C. (2004). "Income-related Inequality in the Use of Medical Care in 21 OECD Countries". *OECD Health Working Paper No.14.* OECD, Paris.

van Doorslaer E, Wagstaff A, Bleichrodt H, Calonge S, Gerdtham U, Gerfin M, Geurts J, Gross L, Häkkinen U, Leu R, O'Donnell O, Propper C, Puffer F, Rodriguez M, Sundberg G and Winkelhake O. (1997), "Socioeconomic inequalities in health: some international comparisons", *Journal of Health Economics*, 16(1): 93-112.

van Kippersluis H, and Galama T. (2013), "Why the Rich drink More but smoke Less: The Impact of Wealth on Health Behaviors". *Tinbergen Institute Discussion Paper TI 2013-035/V*.

Woodward A, and Kawachi I. (2000), "Why reduce health inequalities?" *J Epidemiol Community Health,* 54:12 923-929.

General Introduction

This thesis deals with social inequalities in health-related behaviours such as lifestyle risk factors for health (precisely, obesity and alcohol consumption) and the utilisation of health care services, in a number of OECD countries. This work relies on a micro-econometrics approach, using a range of national health survey data. This thesis aims to (a) compare social inequalities in health-related behaviours across countries with different settings; (b) shed light on the understanding of social disparities in health-related behaviours; and (c) examine how self-reporting may affect the rating of behavioural risk factors, and therefore affect the measurement of social inequalities.

This general introduction is composed of four sections. Section 1 provides some background on health inequalities. Section 2 focuses on the determinants of health inequalities. Section 3 highlights the contribution of international comparisons. And, Section 4 presents the outline of this thesis.

1. Background

Disparities in health status (measured by mortality or morbidity) have been largely documented in the international literature in relation to gender, ethnicity, social background, education, socioeconomic status[1], and geographical area (van Doorslaer *et al.,* 1997; Mackenbach *et al.,* 2008; OECD 2011). Studies on disparities in mortality and morbidity by socioeconomic status reveal that the worst-off die prematurely compared to the better-off, and that the poorest part of the population, the most vulnerable, are more affected by illness. Eurostat (2010) started to measure disparities in life expectancy by education level in European countries on a regular basis. The latest data shows that education-related gaps in life expectancy at age 30 vary from 2.5 years in women in Slovenia to 17 years in men in Estonia.

A number of studies aimed to understand health inequalities and to explore their determinants (Eurothine project; ECuity project; van Doorslaer and Koolman, 2004; Cutler and Lleras-Muney, 2010). Over the past 10 years, a lot of attention was paid to the determinants of health, notably under the WHO Commission on the Social Determinants of Health initiated in 2005. The work carried out by this Commission led to the publication of a main report in 2008: *Closing the gap in a generation*, followed by the 2011 Rio Political Declaration on Social Determinants of Health pledging to work towards reducing health inequities.

[1] Socioeconomic status here refers to income or occupation.

Health inequalities are of major concerns for governments for two main reasons: they are unfair and they are source of social costs. First, health inequalities are unfair since they may occur from early childhood, and because everyone does not have the same opportunity for good health (Trannoy *et al.,* 2010). Inequalities of opportunity linked to circumstances in childhood represent 46% of social inequalities in health (Jusot *et al*., 2013). Besides, these inequalities are avoidable given that better design of policy interventions may help reduce them (Woodward and Kawachi, 2000). Second, health inequalities may have broader societal impacts in terms of global welfare and labour market outcomes, poor health being associated with poor educational attainment and negative labour market outcomes. Mackenbach *et al.* (2011) estimate the monetary value of health inequality-related welfare losses at 9.4% of GDP. For these reasons, governments are increasingly paying attention to measuring and understanding health inequalities, in search of the most appropriate measures to tackle them.

2. The determinants of health inequalities

Health status is influenced by a variety of determinants: genetics[2], individual and contextual factors. Individual factors refer to social condition and individual choices, including living and working conditions, education level, socioeconomic status, integration in social life, health-related lifestyle behaviours (such as smoking, drinking, diet and physical activity), as well as the demand for health care services. Contextual factors refer to multiple surrounding dimensions, including national wealth, income inequality, health system features (e.g. supply of health care services, free access at point of care delivery, health prevention policy), social norms, and environment factors (e.g. transport and pollution). All these determinants have an effect on health status, and interactions between them may influence health status more or less strongly. Understanding health inequalities relies heavily on the understanding of the relationships between socioeconomic factors, behaviours and health. The analysis framework of this thesis proposes to study social inequalities in behavioural risk factors and in health care utilisation as a means of addressing social inequalities in health. As shown below, this framework is consistent with Grossman's model and its extensions.

[2] This discussion leaves apart genetic factors, as they are not generally in the action target of governments. However it is worth noting that more and more attention is paid to the genomics, the science of genomic sequences, that is promising in the coming years to help to detect and prevent diseases such as cancers and cardio-vascular diseases.

2.1. Theoretical framework

Grossman (1972, 2000) developed an economic framework for the demand for health based on the human capital theory. In this framework, health is a capital which depends on the initial stock and depreciates over time, but can be increased with investment in health. Individuals are active producers of their health, buying market inputs (e.g. health care, food) and combining them with their own time to increase their utility. Education increases efficiency in the production of health since more educated people are in a better position to process health information, and make better investment in health. Grossman's model provides a theoretical framework for making predictions of health as a function of education and socioeconomic status, which are positive determinants of the investments in health. Thus, Grossman's model is a solid foundation for the study of inequality in health (Galama and van Kippersluis, 2013).

As investment in health is a key concept in this model, lifestyle behaviours and individual preferences play an important role in this theoretical framework. A number of studies confirm the impact of health-related behaviours on social inequalities in health (McGinnis and Foege, 1993; Contoyannis and Jones, 2004; Stringhini *et al.,* 2010). However, unhealthy behaviours may not all contribute to determining health status to the same degree or in the same direction. While smoking contributes largely to the well-known gradient of social health inequalities, drinking behaviours may sometimes contrast. Van Kippersluis and Galama (2013) study why the rich drink more but smoke less, and they propose a theory of health behaviours to explain why richer people engage more in moderate unhealthy behaviours and less in harmful behaviours[3].

In Grossman's model, education and socioeconomic status are correlated to health. This correlation has been widely validated in empirical studies. However, evidence for a causal relationship remains debated. The challenge is to identify whether the social gradient in health reflects a causal link from socioeconomic status to health, or a reverse causality from health to social outcomes. This question has been studied in the literature leading to mixed findings. Evidence goes in both directions, showing for example that health influences labour (Morris, 2007; Lundborg *et al.*, 2010; Burton *et al*. 1998) and labour

[3] Van Kippersluis and Galama (2013) assume that the decision to engage in unhealthy consumption is governed by the monetary cost of the good and the health cost related to the consumption of the good (i.e. value of health lost). They assume that wealth influences health behaviours via two competing effects: the *direct* wealth effect that increases the demand for (unhealthy) consumption goods; and the *indirect* health cost effect that decreases the demand for unhealthy consumption goods (since the health cost is higher for those who invest in health i.e. the more affluent).

influences health status (Llena-Nozal, 2009; Robone *et al*. 2011). About the latter, the impact of labour on health status has been shown to be positive in some studies and negative in others, but a convergence in findings emerges, suggesting that the negative health impact of work is related to situations in which workers have essentially no control (no choice) over the amount of work they provide (Bassanini and Caroli, 2014).

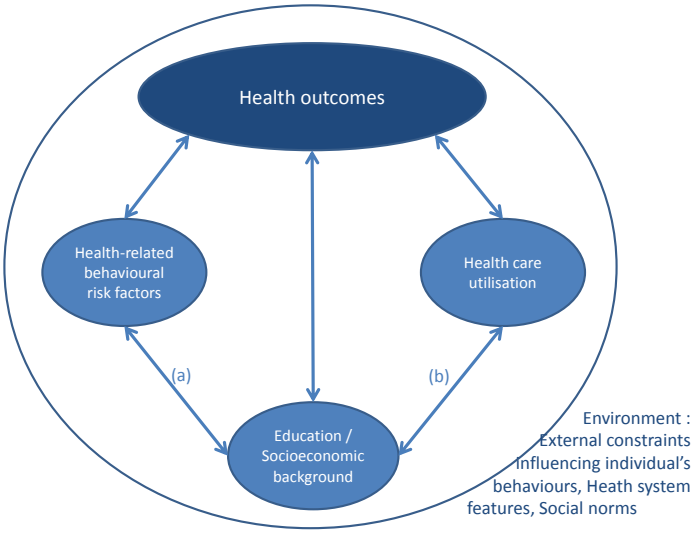
When studying inequalities in health-related behaviours, one important dimension to consider is individual time preferences i.e. whether people value more short-term satisfaction rather than long-term consequences of their health behaviours. In particular, about health-related and addictive behaviours, individuals must often make the trade-off between immediate satisfaction of unhealthy goods consumption (e.g. food high in fat and sugar, tobacco, and alcohol) and future losses in health capital. Economic models for addictive goods were originally introduced by Becker and Murphy (1988) with the rational addiction theory which assumes that the consumer is aware of the future consequences of addictive goods consumption and accounts for them when making consumption choices. This model relies on the idea that current preferences for addictive goods depend on past and anticipated consumption of that goods. The rational addiction theory finds support in empirical studies, in particular in relation to smoking (Chaloupka and Warner, 2000; Clark and Etilé, 2002).

Individual time preferences are correlated to education and socioeconomic status, with little evidence on the direction of causality. Individuals who discount the future less (i.e. who have a preference for future) invest more in education and engage more in healthy behaviours (Fuchs, 1982). Similarly, less educated and poorer people discount the future more heavily than richer people (Becker and Mulligan, 1997). The interplay between time preferences, health behaviours, and education is therefore of importance for the study of social inequalities in health-related behaviours. Individual time preferences may affect the relationship between education and health by having a mediating role of social health inequalities, as suggested by empirical studies (van der Pol, 2011; Jusot and Khlat 2013).

2.2. Focus on social inequalities in health-related behaviours

Figure 1 illustrates the analysis framework of this thesis wherein social disparities in health outcomes results from direct and indirect pathways of social determinants. Tackling social inequalities in health can be achieved to some extent by addressing inequalities in behavioural risk factors and inequalities in health care utilisation.

Figure 1. Determinants of social inequalities in health



Source: Author.

Differences in morbidity and mortality may be directly related to living and working conditions (e.g. type of occupation that may have inherent cancer risks), but they may also emerge from between-groups differences in behavioural risk factors (e.g. smoking, obesity, alcohol use) (arrow (a) in Figure 1) and differences in health care services utilisation (e.g. doctor consultations) (arrow (b)). Lifestyles and behavioural risk factors play an important role in the relationship between health and socioeconomic factors. They are often significantly influenced by education and socioeconomic status and, at the same time, they contribute to health and longevity by affecting the probability of developing a wide range of diseases (e.g. cardiovascular diseases, diabetes, cancers, musculoskeletal diseases, mental ill-health). Similarly, access to health care is as important as lifestyle in the determination of social health inequalities. For example, higher-income people are shown to have better access to health care services, which translates into differences in health outcomes.

Thus, reducing social health inequalities depends not only on efforts directly made to improve health outcomes of the worst-off, but also efforts to reduce social inequalities in behavioural risk factors and health care utilisation. In addition to health-related behaviours, external factors may interact with and exacerbate or diminish social inequalities in health. For instance, there are potential interactions with contextual and environmental factors, such as health system characteristics (e.g. density of medical

services, copayment system), social norms, transport and pollution. This aspect is further discussed in Chapter 4, with the analysis of health system characteristics as determinants of inequities in health care utilisation.

3. How can international comparisons contribute?

3.1. The importance of cross-country comparisons

This research focuses on measuring and comparing social inequalities in health-related behaviours with the aim of making the best use of multi-country analysis. International studies (either qualitative or quantitative, sharing country experiences or making cross-country comparisons) allow policy makers to learn from other countries about good practices and to understand the impact of policies, although they do not go without difficulties.

International studies can help countries develop their knowledge and understanding, and they favour the introspection, enabling change in the way of thinking and identifying problems. Cross-national evaluations enable to draw an accurate picture of the situation, to identify where problems are, how other countries deal with it, and which countries perform better, how and why. International comparisons also provide a basis for exploring the relationships between country performance and policy setting, and more specifically, they offer a source of knowledge and evidence for better understanding of the impact of public policies. However, such cross-national research is not without difficulties. Conceptual and practical problems often emerge when undertaking international comparisons, including issues in availability and comparability of data, discrepancies in national settings and institutional features.

This thesis focuses on the analytical and methodological aspects of cross-country evaluation rather than policy comparisons. This work does not intend to review national policies in place or to propose a set of good practices. Instead, it aims at drawing an accurate picture of inequalities across countries, collecting national survey data, making data comparable, and developing comparable measures. Also, this thesis raises methodological issues and questions around the interpretation of results for the best use of policy recommendations.

3.2. Cross-country studies on inequalities in health

There are two initiatives at the European level, initiated in the 1990s, which aim to measure and understand inequalities in health (Jusot, 2010). Funded by the European Commission, these two projects highlight the existence of health inequalities, and the great variation in health inequalities across countries, but they also study inequalities in health-related lifestyle behaviours and inequalities in access to health care.

First, the EU Working Group on Socioeconomic Inequalities in Health, followed by the collaborative research programme Eurothine (Tackling Health Inequality in Europe) led by Johan Mackenbach and Anton Kunst, showed that health inequalities were substantial throughout the European Union in the 1990s, and that important variations in the magnitude of health inequalities exist between countries, suggesting scope for reducing health inequalities. More recently, the subsequent and related European project EURO-GBD-SE has identified the most important entry-points for policies aimed at reducing health inequalities (Eurothine project).

Second, the ECuity project was initiated in the early 1990s, and led by Eddy van Doorslaer, Adam Wagstaff and Andrew Jones. Overall, the project brought significant methodological breakthroughs and important new results focussing on the following areas: inequity in health care financing, inequity in health care delivery, inequity in health care utilisation, and inequalities in health status. The current ECuity III project extends the analysis to determinants of health care demand (e.g. income inequality, private health insurance, user charges) and the causal relationships to inform policy makers (ECuity project).

An extension of this work was the OECD Equity project with the objective to cover a larger set of countries (van Doorslaer and Masseria, 2004). This research focussed on inequity in health care utilisation by income level, and encompassed 21 OECD countries (a number of European countries, as well as Australia, Canada, Mexico, USA). This project highlighted pro-poor inequities in general practitioners (GP) visits and pro-rich inequities in doctor and specialist visits in a number of countries.

It is important to recognise that these projects could not exist without efforts to develop harmonised health survey data at the European level (e.g. European Community Household Panel, European Health Interview Survey, Survey of Health And Retirement in Europe). As governments pay more attention to health inequalities, technical efforts are continuously made at the international level to

monitor and understand these inequalities. For instance, the regular monitoring of health inequalities at Eurostat now includes the new measure of differences in life expectancy by education level.

These two important programmes of work on the measurement and understanding of health inequalities and possible ways of tackling them open new ways of research. In particular, more research may be needed to extend country coverage to non-European countries. In addition, the field of statistics and econometrics sees continuous methodological developments, and new techniques may help to improve previous research. For instance, new developments of the measurement of inequalities enable an improved assessment of cross-country comparison. In particular, when analysing social inequalities in health from an international perspective, it is essential to use appropriate methods to compare inequalities between countries with different settings (e.g. structure of the population, distribution of education level and social class). Aggregate measures of inequalities have been used to overcome this problem. These include the concentration index, the relative and absolute index of inequality, and other recent improvements of these indexes. Further methodological discussion is presented in Chapter 1, and an empirical application is shown in Chapter 2, with the analysis of social inequalities in obesity and overweight in a selection of OECD countries.

3.3. Cross-country studies on inequalities in health-related behaviours

An additional motivation for the topic of this thesis comes from the need for better knowledge of the scope of inequalities in health-related behaviours in a multi-country context, in order to consider and design operable policy instruments oriented towards lifestyle behaviours. Evidence on social disparities in health-related behaviours from an international perspective has to date been poorly informed. Although social inequalities in health have been widely examined for a number of health outcomes, studies have not focused so much on behavioural risk factors. One of the main reasons for this is that health-related behaviours are difficult to measure, suffering from inconsistency and self-reporting bias. For instance, measures of Body Mass Index[4] and obesity may be subject to inaccuracy due to misreported height and weight. Similarly, measures of drinking suffer from self-report bias with strong underreporting of alcohol consumption. Nevertheless, the literature shows a growing number of international studies looking at social disparities in obesity (Mackenbach *et al.*, 2008; Costa-Font *et al.* 2014), in diet and physical activity (Gordon-Larsen *et al.*, 2006; Filippidis *et al.*, 2014), in smoking (Cavelaars *et al.*, 2000; Mackenbach *et al.*, 2008), although less is known about disparities in alcohol consumption.

[4] Body Mass Index is a measure of body mass defined as the ratio of the weight in kg over the square of the height in meter.

In addition, the issue of self-reporting raises the question of whether the self-report bias affects the rating of individual behaviours, and if so, whether the self-report bias varies by socioeconomic group and affects the measurement of social inequalities. There is a small number of studies looking at the self-report bias and disparities in obesity (Cawley, 2000; Lakdawalla and Philipson, 2002; Ljungvall *et al*. 2012; Costa-Font *et al.* 2014). In particular, Ljungvall *et al.* (2012) found evidence on Swedish data that social disparities in obesity are affected by self-report bias in women, but not in men. Costa-Font *et al.* (2014) corroborate this finding since they found on Spanish data that (absolute) inequalities in obesity are stronger after correction for self-report bias, especially in women. However, to our knowledge there is no research on the effect of the self-report bias on social disparities in alcohol consumption. This point is further explored in Chapter 3.

The study of access to health care and demand for care complements the analysis of inequality in behavioural risk factors. The previous section showed that inequalities in morbidity and mortality can be the results of prior inequalities in behavioural risk factors and health care utilisation. Previous studies around the year 2000 have shown that in numerous countries higher-income people compared to lower-income people are more likely to visit doctors, in particular specialists and dentists, and to take up cancer screening, this being true for the same level of needs for health care[5] (van Doorslaer and Masseria, 2004; Or *et al.,* 2008; Bago d'Uva *et al.,* 2009). Since 2000, countries have put in place reforms that may have influence access to care (e.g. gatekeeping system, increase/reduction in copayment, cancer screening programme). Hence, there is a need to re-assess inequities in health care utilisation and to analyse these inequities in the light of the health system characteristics. In particular, in order to best inform policy makers, it will be relevant to identify which health system features characterise countries with a lower degree of inequities. This point is explored in Chapter 4.

4. What does this thesis bring?

4.1. Research questions

Under the broad objective of examining social inequalities in health-related behaviours in different countries, this thesis addresses important research questions regarding the methodology and related

[5] When inequality in health care utilisation remains after adjusting for the level of health care needs, we talk about inequity.

policy implications of social inequalities in health-related behaviours. Research questions explored through this thesis are three-fold and can be summarised as follows:

- How can we compare social inequalities in health across countries with different settings (e.g. structure of the population, distribution of education level and socioeconomic status)?
- Beyond the observation and monitoring of social disparities in health, how can we shed light on the understanding of these disparities? And, how can we best inform policy decision makers?
- How does self-reporting affect the rating of behavioural risk factors? Does self-report bias vary by social group and therefore affect the measurement of social inequalities?

4.2. Outline of this thesis

This thesis deals with social inequalities in behavioural risk factors and utilisation of health care services in a number of OECD countries. The following chapters focus on two behavioural risk factors for chronic diseases: obesity and alcohol consumption. Utilisation of health care services is assessed through examining doctor visits (both GP and specialist), dentist visits, and breast and cervical cancer screening. This thesis relies on a micro-econometrics approach, using data from a number of national health surveys.

Chapter 1 presents the data and methods used in the different pieces of this work. National health survey data from 23 OECD countries were collected. Measures of obesity and alcohol consumption are described and their validity is questioned. In particular, the impact of self-reported outcomes on assessing inequality is questioned. Methods used to assess inequalities such as relative and absolute indices of inequality and concentration indices are presented in this chapter.

Chapter 2 deals with social inequalities in obesity and overweight in a number of OECD countries. This chapter consists of two articles. The first article, co-authored with Franco Sassi, was published in *The European Journal of Public Health* in 2013, and the second article, co-authored with Franco Sassi, Jody Church, Michele Cecchini and Francesca Borgonovi, was published in the *OECD Economics Journal* in 2011. Inequalities in obesity and overweight by education level and by socioeconomic status (SES) are examined using data from national health surveys of 11 countries. The size of inequalities was assessed on the basis of absolute and relative inequality indexes. Large and persistent social inequalities in obesity

and overweight by education level and socio-economic status exist in OECD countries. These are consistently larger in women than in men. Absolute inequalities were largest in Hungary and Spain across the education spectrum. Relative inequalities were largest in France and Sweden with poorly educated men more likely to be obese (and respectively, in Spain and Korea for women).

In addition, a range of analyses conducted for Australia, Canada, France, England and Korea, were undertaken with the aim of exploring the relationship between education and obesity. The findings of these analyses show a broadly linear relationship between the number of years spent in full-time education and the probability of obesity, suggesting that increasing education at any point along that spectrum would be expected to reduce obesity to a similar degree, if the causal link between education and obesity had been established. Causality between education and obesity has not yet been proven with certainty, although evidence from France suggests that the direction of causality appears to run mostly from education to obesity. Moreover, most of the effect of education on obesity is direct. Last, further analyses show not only an absolute effect of the education level on obesity, but also a relative effect, *i.e.* the individual's education level relative to the peers' education level has an influence on obesity.

Chapter 3 focuses on disparities in alcohol consumption across education levels and socioeconomic groups. This study, co-authored with Franco Sassi, is currently under review in the *European Journal of Public Health*. The analysis covers 13 countries and aims to identify which population groups most often engage in hazardous drinking and it assesses how self-report bias may affect social inequalities in drinking. Results show that socioeconomic disparities in hazardous drinking are intertwined with gender differences. More educated women are more likely than less educated women to engage in hazardous drinking, while the opposite is observed in men in most countries. Large discrepancies in alcohol consumption between survey-based and aggregate consumption estimates were found. Correcting for self-report bias increased estimates of social disparities in women, and decreased them in men, to the point that gradients were reversed in several countries (from higher rates in less educated/SES men to an opposite pattern). While acknowledging the limitations of the approach used for correction, this study provides evidence of a likely mis-estimation of social disparities in alcohol consumption, in both men and women, due to self-report bias in surveys of alcohol consumption. Correcting for self-report bias leads to a relatively larger increase in hazardous drinking rates in higher educated/SES people. This study contributes to a better knowledge of the social dimensions of alcohol drinking and can therefore help in the targeting of alcohol policies.

Chapter 4 investigates inequalities in the utilisation of medical services. This chapter was published in *The European Journal of Health Economics* in 2013. Income-related inequalities and inequities in health care service utilisation are assessed in 18 countries by the means of concentration indices. The analysis focuses on doctor and dentist visits, and breast and cervical cancer screening. In most countries, for the same health care needs, people with higher incomes are more likely to consult a doctor than those with lower incomes. Pro-rich inequalities in dental visits and cancer screening uptake are also found in nearly all countries, although the magnitude of these varies among countries. Part of the cross-country discrepancies can be explained by the differences in health system characteristics. In particular, larger inequities are found in countries where: universal health coverage is not achieved, health care financing relies on a large share of private insurance and out-of-pocket payments, GPs do not act as gatekeepers, health care provision is mostly private and national cost-sharing arrangements do not include free care at the point of delivery.

Finally, a general conclusion provides a discussion of the main findings in the light of the objectives of this thesis, and opens up discussion around methodological considerations and policy recommendations that can be drawn.

REFERENCES

Bago d'Uva T, Jones AM, van Doorslaer E. (2009). "Measurement of Horizontal Inequity in Health care Utilisation Using European Panel Data". *Journal of Health Economics*, 28 :280-289.

Bassanini A, Caroli E. (2014), "Is Work Bad for Health? The Role of Constraint vs Choice". *IZA Discussion Paper No. 7891*.

Becker GS and Mulligan CB. (1997), "The endogenous determination of time preference". *Quarterly Journal of Economics*, 112:729–758.

Becker GS and Murphy KM. (1988), "A Theory of Rational Addiction". *Journal of Political Economy*, 96(4):675-700.

Burton WN, Chen CY, Schultz AB and Edington DW. (1998), "The Economic Costs Associated with Body Mass Index in a Workplace", *J. Occup. Env. Med*., 40(9):786-792 .

Cavelaars A, Kunst A, Geurts J, Crialesi R, Grotvedt L, Helmert U, Lahelma E, Lundberg O, Matheson J, Mielck A, Rasmussen N Kr, Regidor E, do Rosario-Giraldes M, Spuhler Th, Mackenbach J. (2000), "Educational differences in smoking: international comparison". *BMJ*, 320:1102–7.

Cawley J. (2000), "Body Weight and Women's Labor Market Outcomes", Cambridge, MA, National Bureau of Economic Research, Working Paper No. 7841.

Chaloupka FJ and Warner KE. (2000), "The Economics of Smoking", in A.J. Culyer and J.P. Newhouse (eds.), Handbook of Health Economics, Oxford, North Holland.

Clark A and Etilé F. (2002), "Do health changes affect smoking? Evidence from British panel data". *Journal of Health Economics*, 21(4):533-562.

Contoyannis P, Jones A. (2004), "Socio-economic status, health and lifestyle". *Journal of Health Economics*, 23: 965-995.

Costa-Font J, Hernandez-Quevedo C, Jimenez-Rubio D. (2014), "Income inequalities in unhealthy life styles in England and Spain". *Economics and Human Biology*, 13:66–75.

Cutler D, Lleras-Muney A. (2010), "Understanding differences in health behaviors by education". *Journal of Health Economics*, 29: 1–28.

ECuity project, website available at: http://www2.eur.nl/bmg/ecuity/

Eurostat (2010), "Highly educated men and women likely to live longer". Available at: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-10-024/EN/KS-SF-10-024-EN.PDF

Eurothine project, website available at http://www.euro-gbd-se.eu/

Filippidis FT, Schoretsaniti S, Dimitrakaki C, Vardavas CI, Behrakis P, Connolly GN, Tountas Y. (2014), "Trends in cardiovascular risk factors in Greece before and during the financial crisis: the impact of social disparities". *European Journal of Public Health*. doi: 10.1093/eurpub/cku028

Fuchs VR. (1982), "Time preference and health: An exploratory study". In VR Fuchs (eds), Economic aspects of health. Chicago: University of Chicago Press. 93–120.

Galama T and Van Kippersluis H. (2013), "Health Inequalities through the Lens of Health Capital Theory: Issues, Solutions, and Future Directions". Tinbergen Institute Working paper No. 13-076/V.

Gordon-Larsen P, Nelson MC, Page P, Popkin BM. (2006), "Inequality in the Built Environment Underlies Key Health Disparities in Physical Activity and Obesity". *Pediatrics*, 117(2):417-424.

Grossman M. (1972), "On the concept of health capital and the demand for health". *The Journal of Political Economy,* 80(2), 223-255.

Grossman M. (2000). "The Human Capital Model", in Culyer A.J., Newhouse J.P. (eds), Handbooks of Health Economics, Elsevier: 348-408.

Jusot F (2010) "Les interventions de réduction des inégalités sociales de santé en Europe" in Réduire les inégalités sociales en santé, L. Potvin, M-J Moquet et C. M. Jones (eds), Inpes : 73-88.

Jusot F, and Khlat M. (2013), "The role of time and risk preferences in smoking inequalities: A population-based study". *Addictive Behaviors*, 38:2167–2173.

Jusot F, Tubeuf S, Trannoy A. (2013), "Les différences d'état de santé en France: inégalités des chances ou reflet des comportements à risques? " *Économie et Statistique*, 455-456.

Lakdawalla D, and Philipson T. (2002), "The Growth of Obesity and Technological Change: A Theoretical and Empirical Examination". Working Paper 8946, http://www.nber.org/papers/w8946

Ljungvall Å, Gerdtham U-G, Lindblad U. (2012), "Misreporting and misclassification: implications for socioeconomic disparities in body-mass index and obesity". Lund University Working paper 19. http://project.nek.lu.se/publications/workpap/papers/WP12_19.pdf

Llena-Nozal A. (2009), "The effect of work status and working conditions on mental health in four OECD countries", *National Institute Economic Review*, 209(1):72-87.

Lundborg P, Nystedt P and Rooth D. (2010), "No Country for Fat Men? Obesity, Earnings, Skills, and Health among 450,000 Swedish Men". *IZA Discussion Paper No. 4775*, www.ed.lu.se/papers/iza_lundborg.pdf.

Mackenbach JP, Meerding WJ, Kunst AE, (2011), "Economic costs of health inequalities in the European Union". *J Epidemiol Community Health,* 65:412-419.

Mackenbach JP, Stirbu I, Roskam AR, Schaap MM, Menvielle G, Leinsalu M et al. (2008), "Socioeconomic Inequalities in Health in 22 European Countries". *The New England Journal of Medicine*, 358: 2468-2481.

McGinnis J, Foege WH. (1993), "Actual causes of death in the United States". *Journal of the American Medical Association*, 270, 2207–2212.

Morris S. (2007), "The Impact of Obesity on Employment", *Labour Economics*, 14:413-433.

OECD (2011), How's Life? Measuring Well-Being. OECD, Paris; 2011.

Or Z, Jusot F, Yilmaz E. (2008). "Impact of Health care System on Socioeconomic Inequalities in Doctor Use". *IRDES Working Paper No.17.* IRDES, Paris.

Robone S, Jones A and Rice N. (2011), "Contractual conditions, working conditions and their impact on health and well-being", *European Journal of Health Economics*, 12(5):429-444.

Stringhini S, Sabia S, Shipley M, Brunner E, Nabi H, Kivimaki M, Singh-Manoux A. (2010), "Association of socioeconomic position with health behaviors and mortality. The Whitehall II study". *JAMA*, 303(12): 1159–1166.

Trannoy A, Tubeuf S, Jusot F and Devaux M, (2010), "Inequality of Opportunities in Health in France : a first pass". *Health Economics*, 19(8):921-38.

Van der Pol M. (2011), "Health, Education and Time Preference". *Health Economics*, 20:917-929.

van Doorslaer E, and Koolman X. (2004), "Explaining the differences in income-related health inequalities across European countries", *Health Economics*, 13: 609–628.

van Doorslaer E, and Masseria C. (2004). "Income-related Inequality in the Use of Medical Care in 21 OECD Countries". *OECD Health Working Paper No.14.* OECD, Paris.

van Doorslaer E, Wagstaff A, Bleichrodt H, Calonge S, Gerdtham U, Gerfin M, Geurts J, Gross L, Häkkinen U, Leu R, O'Donnell O, Propper C, Puffer F, Rodriguez M, Sundberg G and Winkelhake O. (1997), "Socioeconomic inequalities in health: some international comparisons", *Journal of Health Economics*, 16(1): 93-112.

van Kippersluis H, and Galama T. (2013), "Why the Rich drink More but smoke Less: The Impact of Wealth on Health Behaviors". *Tinbergen Institute Discussion Paper TI 2013-035/V*.

Woodward A, and Kawachi I. (2000), "Why reduce health inequalities?" *J Epidemiol Community Health,* 54:12 923-929.

Chapter 1.

Data and methods

This thesis assembles four pieces of applied micro-economics research that focus on (i) obesity and overweight, (ii) risky alcohol consumption, and (iii) health care services utilisation. These four studies are based on health survey data for a number of countries. The first part of this chapter presents the data sources used, issues of cross- country comparability and survey data limitations. The second part of this chapter describes the methodological approaches applied to measuring inequalities in a cross-country perspective.

1. DATA

This section consists of three parts. First the data are described, then data comparability and construction of variables are discussed, and finally, the data limitations are presented.

1.1. Data sources

Data sources for this work rely on national health interview surveys. Health interview surveys generally collect information from individuals on socio-demographic characteristics, living and working conditions, perceived and objective health status (e.g. acute and chronic diseases), health-related behaviours (e.g. smoking, drinking, physical activity, diet), and their utilisation of health services (e.g. doctor consultation, preventive screening).

Data were gathered from national health and lifestyle surveys for 23 high-income countries: Australia, Austria, Belgium, Canada, Czech Republic, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Japan, Korea, New Zealand, Poland, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom (England), and USA. However, all of these countries are not included in the four papers due to data availability and limitations in areas covered by the surveys. Table 1 lists the national health surveys used in the different pieces of work, and the national institutions supplying the data.

All analyses presented in this thesis use the sampling weights provided with the data.

Table 1. List of national health surveys used

Country	Survey name	Data provider
Australia	National Health Survey 2007-08	Australian Bureau of Statistics
Austria	Österreichische Gesundheitsbefragung 2006/07 (EHIS)	Eurostat for the EHIS version
Belgium	Belgium Health Survey 2008 (EHIS)	Operational Direction Public Health and Surveillance of the Scientific Institute of Public Health (WIV-ISP)
Canada	National Health Population Survey and Canadian Community Health Survey 2009/10	Statistic Canada
Czech Republic	European Health Interview Survey in the Czech Republic 2008 (EHIS)	Institute of Health Information and Statistics (UZIS)
Estonia	Estonian Health Interview Survey 2006/07 (EHIS)	Eurostat for the EHIS version
Finland	Finrisk 2007 / Welfare and services Survey (HYPA -survey) 2009	National Institute for Health and Welfare (THL)
France	Enquête Santé et Protection Sociale 2008-10	Institute for Reseach and Information in Health Economics (IRDES)
Germany	Epidemiological Survey on Substance Abuse 2009 / German Telephone Health Interview Survey (GEDA) 2009	ESA: GESIS - Leibniz Institute for the Social GEDA: Robert Koch Institute
Hungary	European Health Interview Survey (EHIS) 2009	Hungarian Central Statistical Office
Ireland	Survey on Lifestyle And Nutrition 2007	Irish Social Science Data Archive
Italy	Condizioni di Salute 2005 / Multiscopo Aspect of Daily Life 2010	Italian National Institute of Statistic
Japan	National Survey on Alcohol Drinking and Lifestyle 2008	Tottori University
Korea	Korean National Health and Nutrition Examination Survey 2008	Jointly carried out by the Korean Institute for Health and Social Affairs and the Korean Health Industry Develpment Institute
New Zealand	National Health Survey 2006/07	Ministry of Health
Poland	Europejskie Ankietowe Badanie Zdrowia 2009 (EHIS)	Eurostat for the EHIS version
Slovak Republic	Európsky prieskum zdravia 2009 (EHIS)	National Health Information Centre (Ministry of Health)
Slovenia	Anketa o zdravju in zdravstvenem varstvu 2007 (EHIS)	Institute of Public Health
Spain	Encuesta Nacional de Salud de Espana 2006 / Encuesta Europea de Salud 2009	Instituto Nacional de Estadistica and Ministry of Public Health, Social Services and Equality
Sweden	Swedish Level of Living Survey 2000	Swedish Institute for Social Research
Switzerland	Swiss Health Survey 2007	Swiss Federal Statistical Office
United Kingdom	British Household Panel Survey 2009 / Health Survey for England 2008-2009	BHPS: Institute for Social and Economic Research HSE: Office for Population Censuses and Surveys (1991-1993), then (since 1994) conducted by the Joint Survey Unit of the National Centre for Social Research (NatCen) and the Department of Epidemiology and Public Health at University College London
USA	National Health and Nutrition Examination Survey 2009-10 / National Survey on Drug Use and Health 2009-10 / Medical Expenditure Panel Survey 2008	NHANES: National Center for Health Statistics (NCHS - CDC) NSDUH: Substance Abuse and Mental Health Services Administration (SAMHSA) MEPS: Agency for Health Care Research and Quality

1.2. Data comparability and construction of variables

Although the use of different national surveys may be a source of data heterogeneity across countries, all the variables derived for our analyses were constructed in order to get the highest level of comparability across countries. This section discusses the construction of the dependent and independent variables used in the four papers. The dependent variables are related to: (i) obesity and overweight, (ii) risky alcohol consumption, and (iii) health care services utilisation.

1.2.1. Obesity and overweight

The Body Mass Index (BMI) is a measure of weight-for-height that enables to identify overweight and obesity status. It is equal to the weight (in kg) divided by the height (in meter squared). The same BMI thresholds were used in all countries to define overweight (BMI of 25 and over) and obesity (BMI of 30 and over), although there are suggestions that lower thresholds should be used in Asian populations (WHO, 2004). Building cross-country comparable measures of obesity and overweight is then straightforward although some caution should be taken due to discrepancies in self-reported and measured data on height and weight (see discussion in 1.3. Data limitations).

1.2.2. Risky alcohol consumption

International comparisons in alcohol consumption need to rely on a common measure of alcohol level. Each country establishes its own national guidelines for the definition of a standard drink (how much pure alcohol is contained) and recommendation for harmful drinking limits (defined as number of glasses or amount of pure alcohol per week). No international consensus in drinking guidelines currently exists (Furtwaengler and de Visser, 2013). Despite this limitation, comparable drinking outcome measures were derived using information on individual quantity and frequency of drinking provided in national health surveys. The outcome measures include:

- Drinking status, indicating whether people drank any alcohol or were abstainers in the past 12 months.
- Hazardous drinking, corresponding, in this study, to a weekly amount of pure alcohol of 140 grams or more for women, and 210 grams or more for men. This measure refers to the limits above which people are at risk for their health. These thresholds correspond with the national

recommendations used in most countries (2 drinks per day for women and 3 drinks for men) although they differ slightly from those used by the WHO[6] (Rehm *et al.*, 2004).

- Heavy episodic drinking (HED), commonly called binge drinking, is collected in most of the national surveys through a question of the type: "In the past 12 months, how often did you have (n) or more drinks on one occasion?" (where n=5 drinks in Canada, Germany, and the US; 6 drinks in Czech Republic, France, Hungary, Ireland, Italy, New Zealand, Slovak Republic, and Slovenia; 7 drinks for men and 5 drinks for women in Australia; and 8 drinks for men and 6 drinks for women in Switzerland). Our analyses focused on regular HED, i.e. at least one episode per week.

1.2.3. Health care services utilisation

Regarding health care services utilisation, the analysis focuses on visits to (i) doctors (in most countries further information on separate GP and specialist visits are available); (ii) dentists; and (iii) breast and cervical cancer screening services for women. Both the probability and frequency of services were measured over the past 12 months. Typically, a first survey question assesses the probability of a visit, and is of the form: "In the past 12 months have you visited a GP?". A second question measures the frequency of visits in the past 12 months. For breast cancer screening, our focus was on women aged 50-69 years who reported having a mammogram in the past 2 years, and for cervical cancer screening, women aged 20-69 years who had a Pap smear in the past 3 years[7].

1.2.4. Independent variables

National health surveys provide socio-demographic information on adults such as gender, age, ethnicity, marital status, working status, education level, and socioeconomic status (occupation-based or income level). Ethnicity is provided in few countries, namely, New Zealand (European / Maori / Pacific people / Asian and others), the UK (White / Black / Indian, Pakistani, and Bangladeshi / Others), and the US (Non-Hispanic White / Non-Hispanic Black / Mexican American / Others). For the purpose of the analyses, marital status is categorized into Married / Single / Other (divorced, separated, widow). Working status is defined as Working / Not working.

[6] The WHO uses four risk drinking groups founded on epidemiological evidence. The first group refers to abstainers. Category I indicates drinkers at low risk (below 20g of pure alcohol daily for women and 40g for men). Category II consists of alcohol use at risk for health (≥20-40g for women and ≥40-60g for men). Category III consists of alcohol consumption that is already causing harm to the drinker, who may also have symptoms of dependence (≥40g for women and ≥60g for men).

[7] To perform international comparisons, the same age range and frequency was adopted as that used for the *OECD Health Data* collection.

1.2.5. Measures of education level and socioeconomic status

International standard classifications, such as International Standard Classification of Education (ISCED) and International Standard Classification of Occupation (ISCO), were used to define education level and socioeconomic status (SES), reducing limitations from data heterogeneity. Education level is recoded into three groups: low (ISCED 0, 1, 2) / medium (ISCED 3, 4) / high (ISCED 5, 6), which broadly correspond to primary, secondary, and tertiary education.

An attempt was made to standardise different occupation-based socioeconomic status, by recoding professions as: lowest (unskilled manual) / middle-low (semi-skilled manual) / middle (skilled manual, non-manual) / middle-high (managerial technical) / highest (professional). A five-level occupation-based socioeconomic status variable was available or could be derived in England, France, Hungary, Italy, Japan, Spain, Sweden and Switzerland. In countries for which an occupation-based social class variable could not be derived, household income was instead used as an indicator of socioeconomic status (Australia, Austria, Belgium, Canada, Czech Republic, Estonia, Finland, Germany, Ireland, Korea, New Zealand, Poland, Slovak Republic, Slovenia, and the US). As much as possible, the equivalised household income was used accounting for the size and composition of households as permitted with the OECD-modified equivalence scale (Hagenaars *et al.*, 1994). Further details on data comparability are available upon request.

1.3. Data limitations

Despite the variety of data sources available, the choice of health surveys used in this work was mainly driven by data availability and comparability criteria. This section first presents and discusses data limitations, and then focuses on issues with self-reporting and the possible correction procedures to overcome this problem.

1.3.1. National and international data sources

Researchers who aim to undertake cross-country comparisons generally face dual problems of availability and comparability of data at the international level. In particular, for the four studies presented in this thesis, one of the major difficulties was to find adequate data sources, due primarily to the small number of surveys on health and lifestyle behaviours conducted at the international scale, and secondly, because survey data gathered from multiple national sources suffer from heterogeneity from survey design and sampling and inconsistency in survey questionnaires.

Several international surveys were identified but found unsuitable for our analyses.

- The Gallup World Poll is conducted in around 140 countries around the world based on a common questionnaire, translated into the predominant languages in each country. With few exceptions, all samples are probability based and nationally representative of the resident population aged 15 and over in the entire country, including rural areas. Sample sizes are limited to approximately 1000 persons in each country. The survey is undertaken every year in most countries. Although this survey covers health-related issues, questions on medical visits, or data on Body Mass Index (including height and weight) are not included.
- At the European level, three potential data sources were available for the purpose of this dissertation. The European Community Household Panel (ECHP) is a panel survey in which a sample of households and persons has been interviewed yearly. These interviews cover a wide range of topics: income, health, education, housing, demographics and employment characteristic, etc. The total duration of the ECHP was 8 years, running from 1994-2001. The use of ECHP was however rejected since the last survey edition was completed in 2001 and considered too dated for the purpose of our work.
- The European Union Statistics on Income and Living Conditions (EU-SILC) is an instrument aimed at collecting timely cross-sectional and longitudinal multidimensional micro-data on income, poverty, social exclusion and living conditions. Although the EU-SILC contains some information on health, it is not convenient for the analyses presented in this dissertation as it does not cover health-related lifestyles and health care utilisation.
- The European Health Interview Survey (EHIS) consists of four modules of questions on health status, health care use, health determinants, and background variables. These modules may be implemented at a national level either as one specific survey or as elements of existing surveys (i.e. existing national health interview surveys or other household surveys). The first wave of the EHIS was implemented across countries between 2006 and 2009; the second wave is currently on the field. Due to limited data availability, EHIS data was not used for the studies which required trends analyses. However, EHIS was used for the analysis of health care services utilisation.

Some conclusions can be drawn from the data collection experience. Collection and harmonization of micro-data required a major work. Several months were necessary to identify and obtain the micro-data for the 23 aforementioned countries. This work required investigation of numerous national sources of micro-data, selection of data appropriate for the purpose of the analyses, communication with counterparts in the national institutes, and preparation of the legal agreements in order to access the

micro-data files. Given the challenges of data collection and harmonization, the choice of the countries included was mostly guided by data availability. Once the data files were received, significant effort was made to process and harmonize the data, in order to create comparable variables across countries (e.g. cleaning micro-data files and constructing a set of harmonized variables across countries).

Collecting data from different national sources creates a source of data heterogeneity due to survey sampling and survey methods that may differ across countries (e.g. face to face interview, Computer-Assisted Personal Interview technology). This problem could have been minimised if one single international or European survey data source was used, although these surveys are often limited in the richness of data as described above.

The data collection experience revealed some difficulties to get access to data files depending on countries. The UK and the US deliver survey data very timely and easily (e.g. without long process for data use agreement). Timeliness is an important criterion for research purposes; however, it is common to see survey data released two or more years late because of data cleaning and long anonymisation procedures.

Finally, efforts made by international organisations (Eurostat, OECD, WHO) to collect, prepare and distribute comparable health data should be acknowledged. Although international survey data are extremely valuable for research and policy decision making, international initiatives like the EHIS may struggle to expand because of issues related to costs, government priorities, and technical difficulties. For instance, one can observe how difficult it is to find an international consensus on the definition of a harmonised health question module.

1.3.2 Self-report bias: description and impact on measuring inequalities

A key challenge of health survey data is the self-report bias issue that may arise when people provide self-assessed health outcomes and anthropometric measures in surveys. Self-report bias is identified as a systematic error (under- or over-estimation) of health outcomes by certain population groups compared to others. Self-report bias in self-assessed health has been identified in a number of countries (Lindeboom and van Doorslaer, 2004; Jürges, 2007; Hernández-Quevedo *et al*., 2008; Pfarr *et al*., 2012). In our work, the self-report bias issue may arise as presented below.

Obesity

Concerning obesity and overweight, most national health surveys collect self-reported height and weight which tend to underestimate BMI. Only a few health surveys (e.g. the Health Survey for England, the Korean KNHANES, and the US NHANES) provide height and weight measured by clinical examination. This difference in data has a significant impact on the level of obesity and overweight, but to a lesser extent on social inequality. Indeed, the use of self-reported data may potentially bias results, as a number of people tend to report incorrectly their height and weight. However, to our knowledge, there is no clear evidence that self-report bias may vary among individuals with different levels of education or socioeconomic status.

Alcohol consumption

Regarding alcohol consumption, sales data are often regarded as more accurate than health surveys although they have their own limitations. The WHO produces estimates of adult per capita alcohol consumption (APC) based on data from the Global Information System on Alcohol and Health (WHO, 2014), which in turn draws upon various data sources including sales, tax, international trade, and survey data. The APC estimates cover recorded and unrecorded alcohol consumption. The latter refers to homemade or illegally produced alcohol, smuggled alcohol, alcohol for industrial and medical use, alcohol obtained through cross-border shopping, and alcohol consumed by tourists. The unrecorded alcohol consumption accounts for nearly 30% of total worldwide adult consumption. These aggregate APC estimates provide the most reliable information to determine broad national trends and draw country profiles of alcohol consumption.

However, their aggregate nature does not allow identification and examination of individual patterns of drinking. To design appropriate policies, it is desirable to understand how harmful forms of drinking have evolved over time, and to identify which population groups are most likely to engage in harmful drinking. Such analyses help policy makers to target population groups to develop strategies to reduce harmful drinking. Population health and lifestyle survey data providing information on alcohol consumption and individual characteristics are best suited for assessing drinking behaviours across different population sub-groups, although these surveys suffer from important limitations.

Limitations of survey-based data on alcohol consumption are due to measurement bias including underreporting by surveyed respondents and selection bias in survey sampling. Drinking levels reported in surveys have been shown to account for only 40-60% of alcohol sales (Midanik, 1982; WHO, 2011). A

major determinant of such discrepancy is underreporting in surveys (Ely *et al*., 2001; Stockwell *et al*., 2004; Rehm *et al*., 2010; Boniface and Shelton, 2013; Meier *et al*., 2013). For instance, the Health Survey for England in 2002 provides an estimate of 5.8 litres of pure alcohol per capita (population aged 16-75) whereas the WHO estimates recorded adult (15+ years) per capita consumption for the UK as 11 litres[8]. The corresponding figures for Canada are 3 and 8.2 litres, and for the United States 3.6 and 8.7 litres. Another limitation of survey data is a possible measurement error due to the under-sampling of certain groups. In particular, household-based surveys may under-sample groups of people with high alcohol consumption (e.g. students, alcohol dependent people) and may not include at all groups that are most at risk of harmful drinking (e.g., homeless, people in institutions) (Stockwell *et al*., 2004; Meier *et al*., 2013). One more source of bias in survey data is the assumed size and strength of a standard drink. Although many national surveys offer a reminder[9] of the definition of how much pure alcohol is contained in a standard drink, the reported number of standard drinks consumed may differ greatly for different respondents.

Health care services utilisation

Regarding the annual use of health care services, administrative data from health registries or reimbursement files would be more accurate than survey-based data. However, these registries data are difficult (if not impossible) to access due to confidentiality issues and researchers have no other choice than to rely on survey data.

The self-report bias in the literature

Evidence for differences in self-assessed obesity and alcohol use by population group (e.g. gender, ethnicity, education level, social class) is fairly scarce. Cawley (2000) and Lakdawalla and Philipson (2002) analysed the self-report bias in weight in the US (see Box A for example). The underestimation of weight appears to be consistent among women, and larger in heavier men compared to lighter men (Lakdawalla and Philipson, 2002). Concerning alcohol consumption, some research show that underreporting and non-response bias are stronger among heavy drinkers (Townshend & Dukat, 2002; Lemmens *et al*., 1988; Zhao *et al*., 2009, Studer *et al*., 2013).

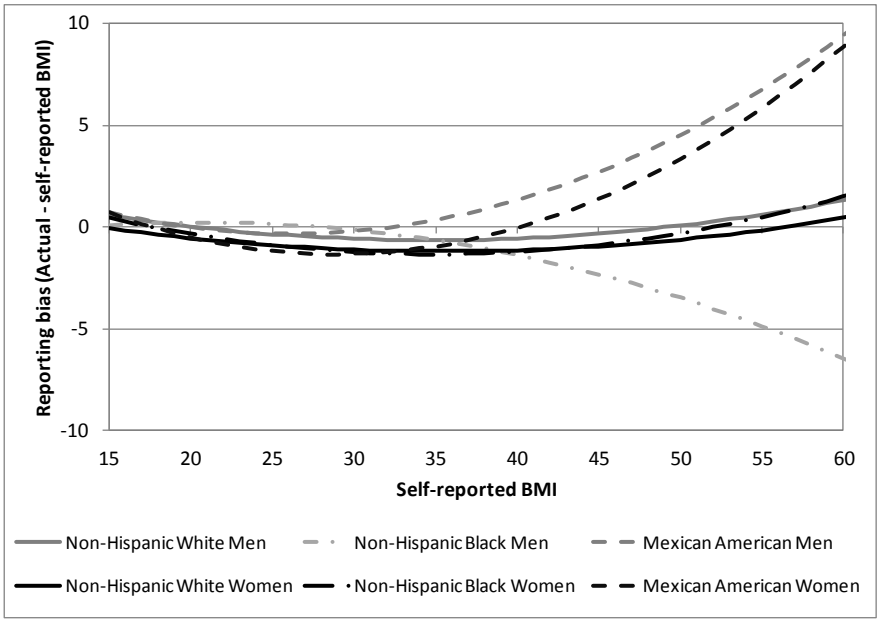
[8] Some of this discrepancy may be due to higher levels of alcohol consumption in other UK countries.

[9] The reminder could be visual (e.g. picture, drawing) or explicit in a short text.

BOX A: *Correcting BMI measure for self-report bias*

Some studies focused on how to correct BMI data from self-report biases. In particular, Cawley (2000) proposed to correct the self-reported NHIS US data from the self-report bias using the measured data on height and weight from the NHANES. The NHANES contain both self-reported and measured height and weight. In order to gauge the self-report bias, we regress the self-reported BMI and its square on the actual BMI by gender and ethnicity. The R-squared is high, indicating that the quadratic function fits the data quite well. Figure A1 shows the size of the self-report bias by gender and ethnicity. BMI is underestimated by obese people (BMI>30) and particularly by Mexican-American men and women. On the contrary, non-Hispanic Black men tend to overestimate their BMI.

Figure A1. Size of the BMI self-report bias by gender and ethnic background



Source: Author's estimates on NHANES data

The coefficient estimates obtained from the previous regression are then applied to correct the self-reported BMI in NHIS data. This correction procedure leads to the same results in terms of the value of regression-based estimates and the strength of correlations with the determinants of inequalities, but the rates of obesity and overweight are higher.

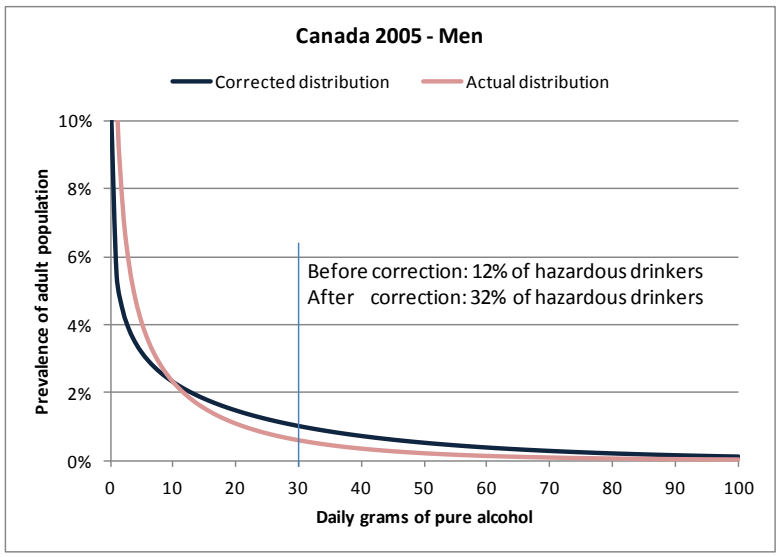
However, few studies investigate the effect of the self-report bias on social inequalities in health-related behaviours. So far, it has been suggested that the self-report bias in obesity does not significantly affect social inequalities (Sassi *et al*., 2009 for USA; Costa-Font *et al*., 2014 for Spain). However, if differences in self-reported measures (e.g. weight, height, number of drinks consumed) were to exist across social groups, then we would expect a significant effect on inequalities. For instance, evidence shows that lower-educated people are more likely than higher-educated people to be obese. If the former (or latter) were more prone to underestimate their weight, then education-related inequalities in obesity would be underestimated (or likewise overestimated). To our knowledge, there is no evidence in the literature on self-report bias in obesity or alcohol use by socioeconomic background. However this thesis provides preliminary evidence that suggests a significant impact of self-report bias on social inequalities in hazardous drinking. The methodology used to correct for self-report bias in alcohol consumption is described in Box B.

BOX B: *Correcting alcohol consumption from underreporting bias*

Several studies propose some attempts to correct the underreporting bias in alcohol survey data. The most recent approach published by Rehm and colleagues is based on the triangulation of survey data with recorded aggregated per capita consumption data by modelling the upshifted distribution of alcohol consumption (Rehm *et al.*, 2010). This correction procedure leads to sizeable change. For instance, this method applied on Canadian data allows the assessment of the magnitude of change in the proportion of hazardous drinkers: the rate of male hazardous drinkers (*i.e. who drink more than 30g of pure alcohol daily*) would increase from 12% (survey-based) to 32% (after correction) (and respectively from 7% to 21% for female). Figure B1 illustrates the shift of the distribution of alcohol consumption.

However, this method uniformly up-shifts the entire distribution of alcohol consumption, although some evidence suggests that the underreporting bias is not evenly distributed and may be larger in hazardous drinkers (Townshend and Dukat, 2002; Lemmens *et al.*, 1988). The lack of an objective measure of alcohol consumption in health surveys prevents an accurate assessment of the size of the self-report bias in different individuals and population sub-groups, which has been possible, in the case of BMI measurement as described above.

Figure B1. Actual and corrected distribution of daily alcohol consumption



Source: Author's estimates on CCHS data

2. METHODS

Analytical approaches used in this work consist of regression-based models and a variety of inequality measures. This section describes the methodology employed to assess inequalities within and across countries.

2.1. Multivariate logistic regression

Multivariate logistic regression analyses were undertaken to assess the link between the studied health outcome and the socioeconomic dimension (either education attainment or socioeconomic status) by adjusting for a range of usual covariates (e.g. age, gender, marital status, ethnicity (when available), smoking status, and occupation status). These variables are further described above in the Data section in this chapter. The advantage of the logistic model lies in providing odds ratios that are easily interpretable as the odds of an event occurring in one group (e.g. the highest socioeconomic group) compared to the odds of it occurring in another group (e.g. the lowest socioeconomic group).

Regression analyses were performed for men and women separately in three of the four studies. In the studies on obesity and alcohol consumption, patterns by education level and SES vary across gender.

Regression models were thus devised for men and women separately (either by performing two separate models or by including gender-education and gender-SES interactions). On the other hand, in the study of health care services utilisation, pooling men and women in the same model with adjustment for gender supposes that the utilisation of health care services only changes by one coefficient between men and women, and that the patterns by SES do not differ between genders.

The use of logistic regressions provides an accurate picture of inequalities within countries. However that approach is less useful in comparisons across countries, and over time, because of differences in the size and nature of socioeconomic groups in different countries and time periods. The use of indices of inequalities permits to overcome, at least in part, the problems just described.

There is a vast literature on the indices of inequalities (Pamuk 1985; Wagstaff *et al.*, 1991; Mackenbach *et al.*, 1997; O'Donnell *et al*., 2008). In this work, health inequalities related to education level and socioeconomic status are assessed using either the relative and absolute indices of inequality, or the concentration index. The following section presents these different measures.

2.2. Relative and absolute index of inequality

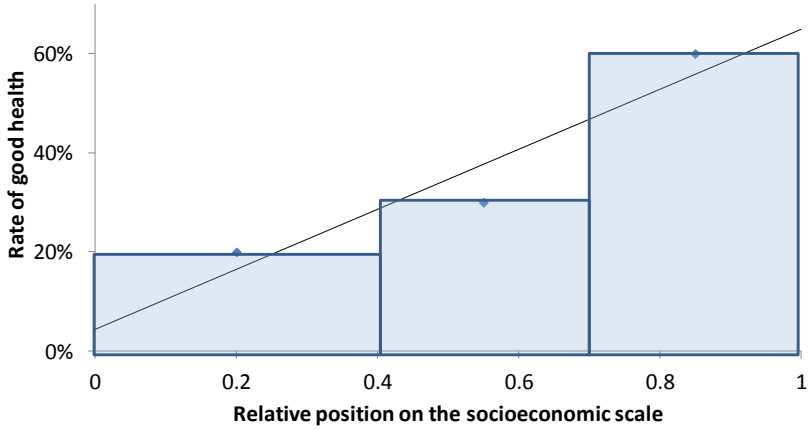
The relative index of inequality (RII) is used to compare the size of health inequalities across countries along two dimensions: education level and socioeconomic status. The RII has been largely employed to analyse socioeconomic inequalities in health across different regions (Mackenbach *et al.*, 2008). The RII is the ratio between the rate of the studied health outcome (e.g. good health) among persons in the bottom socioeconomic group (rank 0) and those in the top group (rank 1) (Pamuk 1985; Mackenbach *et al*., 1997).

For grouped data, the RII is obtained by fitting a regression line for the relationship between the health outcome rate for a particular group and that group's relative position in the social hierarchy as shown in Figure 1. It takes into account the population size and the relative socioeconomic position of the groups, assuming that the socioeconomic groups are ranked in a hierarchical way. For regressions on grouped data, it is more efficient to use Weighted Least Squares estimators to avoid heteroskedasticity of the error term (Wagstaff *et al.*, 1991). This implies that the regression equation is transformed as follows:

$$Y_j\sqrt{n_j} = \alpha\sqrt{n_j} + \beta\sqrt{n_j}X_j + u_j$$

where Y_j is the health outcome of the class j, n_j is the size of the class j, X_j the relative rank of persons in class j, and u_j the error term.

Figure 1. Example of calculation of RII and SII



For (non-grouped) individual data, the RII is calculated by fitting a logistic regression for the probability of good health adjusted for the individual's relative position on the socioeconomic scale, controlling for gender and age.

The slope index of inequality (SII), also called the absolute index of inequality (AII), is derived from the relative index of inequality as a means of gauging the absolute size of inequalities in different countries. The SII is equal to the slope of the above mentioned regression line, and it also corresponds to the difference between the rate for the worst off in the bottom socioeconomic group (rank 0) and the rate for the best off in the top group (rank 1). The SII can be interpreted as the absolute effect on rates in moving from the lowest to the highest ends of the socioeconomic scale.

In the case of negative health outcomes (e.g. being obese), we rank individuals from the highest to the lowest socioeconomic position, so that the RII and SII can be equally derived.

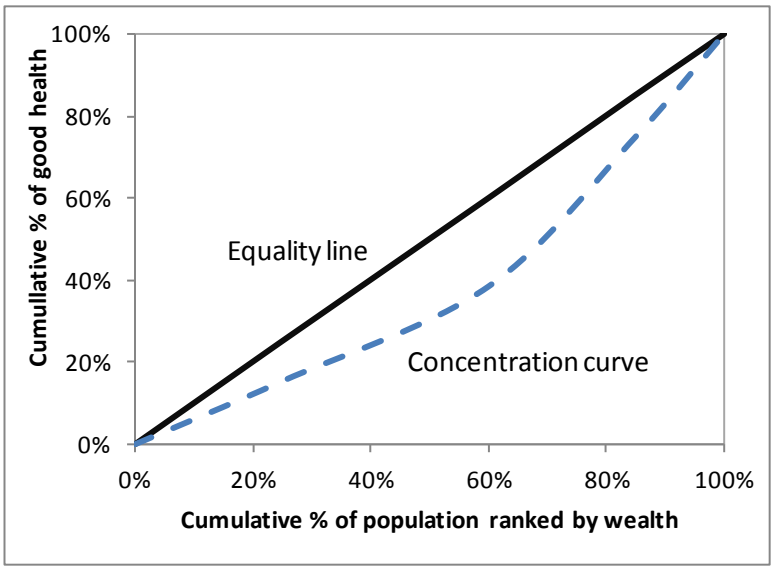
It is worth noting that the relative and absolute indices of inequality are two complementary measures with different properties. The RII is invariant to equiproportionate change, *i.e. if everyone's*

health doubles[10]*, the relative inequality will remain unchanged but the absolute inequality will double*. On the other hand, the SII depends on the difference in health outcomes in the population and is sensitive to the mean value of the health outcomes of the population (Wagstaff *et al.,* 1991). Though, the SII is invariant to uniform change, *i.e. an increase of 10% in the health outcome in all the socioeconomic groups will leave the absolute index unchanged*. In summary, the absolute and relative indices of inequality may vary in opposite ways and so it is important to present both indicators.

2.3. Concentration Index

The concentration index (CI) is defined as referenced to the concentration curve, which graphs on the x-axis the cumulative percentage of the sample ranked by wealth beginning with the poorest and on the y-axis the cumulative percentage of the health variable corresponding to each cumulative percentage of the distribution of the wealth variable (O'Donnell *et al*., 2008). Figure 2 illustrates the concentration curve.

Figure 2. Example of a concentration curve



If the health variable is evenly distributed along the social dimension, the concentration curve coincides with the diagonal (or the line of equality). If good health outcomes are more concentrated among high-income people, then the concentration curve will fall below the line of equality. Conversely if

[10] For instance, if the immunization rate doubles.

good health outcomes are more concentrated among low-income people, the concentration curve is above the diagonal. The farther the concentration curve is from the diagonal, the higher the degree of inequality.

The CI is defined as twice the area between the concentration curve and the equality line, and thus it is bounded between -1 and 1, with the sign indicating the direction of inequality - a positive index indicates pro-rich inequality, a zero value indicates no inequality, and a negative index indicates pro-poor inequality.

The CI of a variable *Y* can be computed using a simple "convenient covariance" formula:

[1] $CI = \frac{2 \times cov_w(yi, Ri)}{\mu}$

where μ is the weighted sample mean of *Y*, cov_w denotes the weighted covariance and *Ri* is the relative fractional rank of the *i*th individual in the social distribution. Another option to obtain robust estimates for CI and its standard error consists in running the following "convenient regression" of the transformed Y on relative fractional rank:

[2] $\frac{2\sigma_r^2}{\mu} Y_i = \alpha_1 + \beta_1 R_i + \varepsilon_{1,i}$

where σ_r^2 is the variance of *Ri* and β_1 is equal to CI, and the estimated standard error of β_1 provides the estimated standard error of CI.

In the case of binary health outcomes, the CI does not satisfy two desirable properties: (a) the range of the index does not vary with the mean of the health outcome Y, and (b) the ranking of countries varies depending on whether the good attribute is coded 0 or 1 ('mirror property'). To solve these issues, Wagstaff (2005) and Erreygers (2009) proposed to normalise the CI to take into account the bounded nature of the binary outcome. The Erreygers index (E) and the Wagstaff index (W) are defined for a binary outcome as follows:

[3] $E = 4 \times \mu \times CI$

[4] $W = \frac{CI}{(1-\mu)}$ where μ is the mean of the health outcome.

Both E and W indices satisfy the two above mentioned properties.

Wagstaff (2011) underlines that the non-normalised CI captures relative inequality, E measures absolute inequality, while W has no dimension. And, it is worth noting that the three measures (CI, E, and W) may lead to different results in terms of size of inequality and countries ranking.

2.4. Discussion of the measures used: pros and cons

Wagstaff *et al.* (1991) have reviewed and compared a range of inequality measures and have highlighted that one of the main advantages of the RII, AII and CI over other inequality measures (e.g. the range, the ratio of the two extremes) is that they capture the socioeconomic dimension of health inequalities by using information from the whole income distribution rather than just the extremes. In addition, these indices offer the advantage that they are statistically comparable across time periods and geographic regions.

On one hand, one advantage specific to the CI is that this index can be decomposed into the contributions of individual factors to social health inequality, this decomposition allowing the explanation of social inequalities in health.

On the other hand, one advantage of the RII and SII is that they are relatively easy to interpret. In contrast, interpreting the CI value is not as intuitive as for the RII and the SII. Although the concentration curves help visualise the results, the value of the CI in itself is somewhat meaningless. Koolman and van Doorslaer (2004) have shown that multiplying the CI value by a fixed coefficient (they estimated at 3/4) gives the proportion of the health variable that would need to be linearly redistributed from the richer half to the poorer half of the population (assuming that health inequality favours the rich) to arrive at equity.

However these indices also present some limitations. Regarding the RII and the SII, the regression estimate of the relationship between health and the social dimension should not show significant deviations from linearity otherwise the magnitude of the index would be biased. This assumes a linear (positive or negative) relationship between health and the socioeconomic ranking, i.e. moving up in the social ranking gradually increases (or gradually decreases) the health outcome. However, this relationship is sometimes curvilinear[11] on actual data, and as a result, the RII and AII might be mis-estimated[12]. To

[11] For instance when health benefits are distributed towards the middle income quintiles.

overcome this issue, Sergeant and Firth (2006) proposed to model the relationship between health and the socioeconomic ranking using cubic splines rather than linear regression. However, this approach seems to be less relevant when socioeconomic ranking is not continuous and composed of few categories.

Although the CI does not require an assumption of linearity, it may fail detecting inequality. If the relationship between health and socioeconomic position is curvilinear, the concentration curve will cross the diagonal and the resulting CI will be close to zero, and thus, be unable to detect inequality.

In conclusion, the use of the CI, the RII and SII presents important advantages for cross-country comparison although some drawbacks need to be addressed carefully.

[12] Although this risk might be reduced when data are grouped and when the number of socioeconomic groups is small.

REFERENCES

Bago d'Uva T, van Doorslaer E, Lindeboom M, O'Donnell O. (2008), "Does Reporting Heterogeneity Bias the Measurement of Health Disparities?". *Health Economics*, 17(3):351-375.

Boniface S and Shelton N. (2013), "How is alcohol consumption affected if we account for underreporting? A hypothetical scenario". *European Journal of Public Health.* Advanced access published. doi: 10.1093/eurpub/ckt016.

Cawley J. (2000), "Body Weight and Women's Labor Market Outcomes". Cambridge, MA, National Bureau of Economic Research, Working Paper No. 7841.

Costa-Font J, Hernández-Quevedo C, Jiménez-Rubio D. (2014), "Income inequalities in unhealthy life styles in England and Spain". *Economics & Human Biology*, 13:66–75.

Ely M, Hardy R, Longford NT, Wadsworth MEJ. (2001), "Methods of estimating individual levels of alcohol consumption in the general population". Alcohol Research UK.

Erreygers G. (2009), "Correcting the Concentration Index". *Journal of Health Economics,*28:504-515.

Furtwaengler N, and de Visser R. (2013), "Lack of consensus in low-risk drinking guidelines". *Drug and Alcohol Review*; 32:11-18.

Hagenaars A, de Vos K, Zaidi MA. (1994), "Poverty Statistics in the Late 1980s: Research Based on Micro-data". Office for Official Publications of the European Communities. Luxembourg.

Hernández-Quevedo C, Jones AM, Rice N. (2005), "Reporting Bias and Heterogeneity in Self-Assessed Health: Evidence from the British Household Panel Survey". York: University of York.

Jürges H. (2007), "True Health vs Response Styles: Exploring Cross-Country Differences in Self-Reported Health". *Health Economics*, 16:163–178.

Koolman X, van Doorslaer E. (2004), "On the Interpretation of a Concentration Index of Inequality". *Health Economics*, 13:649-656.

Lakdawalla D, Philipson T. (2002), "The Growth of Obesity and Technological Change: A Theoretical and Empirical Examination", *Nber Working Paper 8946*, http://www.nber.org/papers/w8946

Lemmens P, Knibbe R A and Tan F. (1988), "Weekly recall and diary estimates of alcohol consumption in a general population survey". *Journal of Studies on Alcohol,* 49:131–135.

Lindeboom M, van Doorslaer E. (2004), "Cut-point shift and index shift in self-reported health". *Journal of Health Economics*, 23(6):1083 – 1099.

Mackenbach JP, Stirbu I, Roskam AR, Schaap MM, Menvielle G, Leinsalu M, *et al.* (2008), "Socioeconomic Inequalities in Health in 22 European Countries". *The New England Journal of Medicine*, 358:2468-2481.

Mackenbach JP, Kunst AE. (1997), "Measuring the Magnitude of Socio-Economic Inequalities in Health: an Overview of Available Measures Illustrated with Two Examples from Europe". *Social Science and Medicine*, 44(6):757-771.

Meier PS, Meng Y, Holmes J, Baumberg B, Purshouse R, Hill-McManus D, *et al*. (2013), "Adjusting for unrecorded consumption in survey and per capita sales data: Quantification of impact on gender- and age-specific alcohol-attributable fractions for oral and pharyngeal cancers in Great Britain". *Alcohol and Alcoholism* doi:10.1093/alcalc/agt001.

Midanik L. (1982), "The Validity of Self-Reported Alcohol Consumption and Alcohol Problems: A Literature Review". *British Journal of Addiction,* 77(4): 357–382.

O'Donnell O., Van Doorslaer E, Wagstaff A and Lingelow M. (2008), "Analyzing Health Equity Using Household Survey Data". The World Bank, Washington D.C.

Pamuk ER. (1985), "Social Class and Inequality in Mortality from 1921 to 1972 in England and Wales". *Population Studies*, 39:17-31.

Pfarr C, Schmid A, Schneider U. (2012), "Reporting Heterogeneity in Self-Assessed Health Among Elderly Europeans". *Health Economics Review,* 2(1):21.

Rehm J, Kehoe T, Gmel G, *et al*. (2010), "Statistical modeling of volume of alcohol exposure for epidemiological studies of population health: the US example". *Population Health Metrics*, 8:3.

Rehm J, R Room, M Monteiro, G Gmel, K Graham, N Rehn, CT. Sempos, U Frick and D Jernigan, (2004), "Chapter 12: Alcohol use", In Ezzati M, Lopez AD, Rodgers A, Murray CJL. eds, Comparative Quantification of Health Risks: Global and Regional Burden of Diseases Attributable to Selected Major Risk Factors, World Health Organization, Geneva.

Sassi F, Devaux M, Cecchini M and Rusticelli E. (2009), "The Obesity Epidemic: Analysis of Past and Projected Future Trends in Selected OECD Countries". *OECD Health Working Papers No. 45*, OECD Publishing.

Sergeant J and Firth D. (2006), "Relative index of ineqaulty: definition, estimation, and inference". *Biostatistics,* 7(2): 213-224.

Stockwell T, Donath S, Cooper-Stanbury M, Chikritzhs T, Catalano P, Mateo C. (2004), "Under-reporting of alcohol consumption in household surveys: a comparison of quantity–frequency, graduated–frequency and recent recall", *Addiction*, 99(8); 1024–1033.

Studer J., S. Baggio, M. Mohler-Kuo, *et al.* (2013), "Examining non-response bias in substance use research—Are late respondents proxies for non-respondents?" *Drug and Alcohol Dependence*, 132: 316–323.

Townshend JM and Dukat T. (2002), "Patterns of alcohol drinking in a population of young social drinkers: a comparison of questionnaire and diary measures", *Alcohol and Alcoholism*, 37(2);187-92.

Wagstaff A. (2005). "The bounds of the concentration index when the variable of interest is binary, with an application to immunization inequality". *Health Economics,* 14:429-432.

Wagstaff A. (2011). "The Concentration Index of a Binary Outcome Revisited". *Health Economics,* 20:1155–1160.

Wagstaff A, Paci P and van Doorslaer E. (1991), "On the Measurement of Inequalities in Health". *Social Science & Medicine*, 33(5):545-557.

World Health Organisation expert consultation (2004), "Appropriate Body-Mass Index for Asian Populations and its Implications for Policy and Intervention Strategies", The Lancet, 363, pp. 157-163.

WHO (2011), "Global status report on alcohol and health". World Health Organization 2011. Switzerland.

WHO (2014), Global status report on alcohol and health. World Health Organization 2014. Switzerland.

Zhao J, Stockwell T, Macdonald S. (2009), "Non–response bias in alcohol and drug population surveys". *Drug and Alcohol Review*, 28:648–657.

Chapter 2.

Social inequalities in obesity and overweight in eleven OECD countries

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ABSTRACT

Background: Evidence of inequalities in obesity and overweight is available mostly from national studies. This paper provides a broad international comparison of inequalities by education level and socio-economic status, in men and women, and over time.

Methods: Data from national health surveys of 11 OECD countries were used. The size of inequalities was assessed on the basis of absolute and relative inequality indexes. A regression-analysis approach was used to assess differences between social groups in trends over time.

Results: Of the countries examined, the United States and England had the highest rates of obesity and overweight. Large social inequalities were consistently detected in all countries, especially in women. Absolute inequalities were largest in Hungary and Spain with a difference of 11.6% and 10% in obesity rates in men, and 18.3% and 18.9% in women, respectively, across the education spectrum. Relative inequalities were largest in France and Sweden with poorly educated men 3.2 and 2.8 times as likely to be obese as men with the highest education (18 and 17 times for women in Spain and Korea, respectively). Pro-poor inequalities in overweight were observed for men in the United States, Canada, Korea, Hungary, Australia and England. Inequalities remained virtually stable during the last 15 years, with only small variations in England, Korea, Italy and France.

Conclusion: Large and persistent social inequalities in obesity and overweight by education level and socio-economic status exist in OECD countries. These are consistently larger in women than in men.

INTRODUCTION

Obesity and overweight rates have increased sharply in the last 20-30 years in OECD countries. The rise in obesity has reached epidemic proportions, with over one billion adults worldwide estimated to be overweight and at least three hundred million obese.[1] Many OECD countries have been concerned not only about the pace of the increase in obesity and overweight, but also about inequalities in their distribution across social groups.[2]

Studies have shown a socio-economic gradient in obesity in a number of countries. Rates tend to be higher in disadvantaged socio-economic groups, whether disadvantage means poor education, low income or low occupation-based social class. Cutler and Lleras-Muney (2006) found that people with more years of schooling in the US are less likely to smoke, drink a lot, be overweight or obese or use illegal drugs, and similarly, that the better educated are more likely to exercise and to obtain preventive care such as flu shots, vaccines, mammograms, pap smears and colonoscopies.[3] Jacobsen and Nilsen (2000) showed that people with higher education in Norway have less fat and more fibre in their diets.[4] Cross-sectional estimates from a study of twins also confirm the negative relationship between education and the probability of being overweight.[5] Although a socio-economic gradient exists in obesity, it does not appear to be as steep as that observed in general health status and in the prevalence of a number of chronic diseases.[6] This finding may be linked to substantial gender differences in the relationship between socio-economic status and obesity. In fact, the overall socio-economic gradient in obesity observed in many countries is an average of a strong gradient in women and a substantially milder gradient, or even the lack of one, in men.[7] Wardle *et al*. (2002) showed on English data, that obesity risk was greater in men and women with fewer years of education and in poorer economic circumstances, and among women, but not men, of lower occupational status.[8] A French study also found that, contrary to women, poorer men are less likely to be obese.[9]

Most existing studies focus on individual countries and only few provide international comparisons. Garcia Villar and Quintana-Domeque (2009) investigated the relationship between household income and body-mass index (BMI) in nine European countries showing an inverse relationship in women and mixed patterns for men, with higher BMI in men from higher-income groups in countries such as Finland and Portugal.[10] Mackenbach *et al*. (2008) explored health inequalities in 22 European countries in relation

to several health outcomes.[11] They focused on education-related inequalities in obesity showing that they were largest in women and in southern European countries. A meta-analysis of fruit and vegetable consumption studies found that adults from disadvantaged socio-economic groups in Europe have less healthy nutrition patterns.[12]

This paper contributes to the existing evidence through an international comparison of social inequalities in obesity and overweight across 11 OECD countries, including several European countries, Australia, Canada, Korea and the United States. Relative to previous comparative studies, this paper broadens the analysis of inequalities to measures of overweight, in addition to obesity, and looks at inequalities by both socio-economic status and education level. Moreover, this paper provides an original analysis of trends in inequalities over time, examining the prevalence of obesity and overweight in different social groups over the past 15 years.

METHODS

Data

Health survey data were obtained from 11 OECD countries: Australia, Austria, Canada, England, France, Hungary, Italy, Korea, Spain, Sweden and the United States. These countries provide a relatively wide geographical spread as well as a varied selection in terms of population rates of obesity and overweight (see Supplementary file No.1). All cross-sectional survey waves available for the last 15 years were used in the analysis.

Survey-specific sampling weights were used when appropriate (Australia, Canada, Hungary, Sweden and the US) and additional special weights were calculated to account for differences in sample size between survey waves. Analyses focused on respondents aged 16 to 65 who reported all the required individual characteristics (gender, age, ethnicity, marital status, education level, socio-economic status, occupation status, smoking status, height and weight). BMI was calculated as weight in kilograms divided by square height in meters. Obesity and overweight were then determined as a BMI equal to or greater than, respectively, 30 and 25.

Education levels were standardised across countries using the ISCED international classification of educational attainment.[13] The relevant variable was categorized into three groups: up to primary school education; lower secondary school education; and, upper secondary school education or more.

Socio-economic status was determined either on the basis of household income or occupation-based social class. Household income was equivalised to account for differences in household size and composition. Occupation was standardised across countries using the ISCO international classification and grouping occupations into five levels, following the model of the English socio-economic classification.[14-15] Occupation-based social class could be derived for Austria, England, France, Hungary, Italy, Spain and Sweden. An occupation-based social class variable could not be derived for Australia, Canada, and Korea, and equivalised household income (in quintiles) was instead used as an indicator of socio-economic status. Finally, a ratio of family income to poverty was used to categorize socio-economic status for the US.

Health examination surveys involving a direct measurement of height and weight were available for England, Korea and the US, whereas other surveys are based on personally administered questionnaires and collect self-reported data on height and weight.

Inequality measures

Absolute and relative indexes were calculated to assess social inequalities in obesity and overweight. These indexes are based on logistic regression estimates of obesity and overweight rates for every socio-economic group. Logistic models were adjusted for a range of relevant covariates: gender, age (assuming a non-linear relationship with obesity and overweight), year of the survey, marital status, ethnicity (when available, *i.e.* in England and the US), smoking status, occupation status, education attainment, socio-economic status and interaction terms between the latter and gender and between education and gender. The use of regression-based inequality indexes makes cross-country comparisons possible when the relative size of social groups varies in different countries.

The absolute, or slope, index of inequality is defined as the slope of the regression line marking the relationship between obesity (or overweight) and the relevant socio-economic variable. The absolute index is obtained using weighted least squares regression as data are grouped.[16] The slope index provides a measure of the absolute size of inequalities, i.e. the difference between the rates estimated for those at the lowest and those at the highest ends of the social scale.

The relative index of inequality is the ratio of the rates estimated for those at the lowest and the highest ends of the social scale. Therefore, the relative index is not sensitive to the overall prevalence of obesity or overweight within a given country.[17-18] All analyses were conducted using Stata 10.

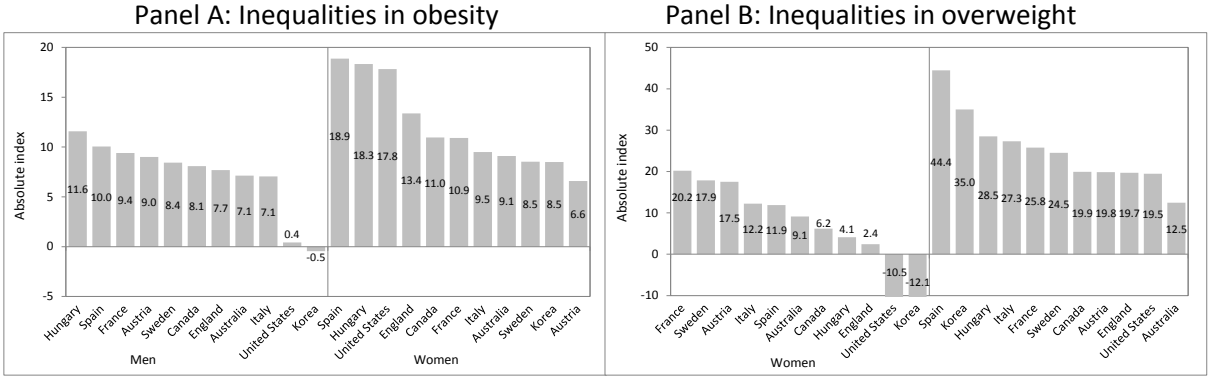
RESULTS

Inequalities by education level

Values of the absolute index of inequality in the 11 OECD countries are displayed in Figure 1. Differences of up to nearly 12 percentage points in obesity rates are observed in men and up to 19 in women, with Spain and Hungary displaying the largest absolute inequalities. Larger education-related inequalities are consistently observed in women than in men, except in Austria. Absolute inequalities tend to be larger in countries with a higher overall prevalence of obesity and overweight, although a large gap is observed in France, where prevalence is relatively low, especially for obesity in men. The absolute index is negative for Korea, but its value is close to 0.

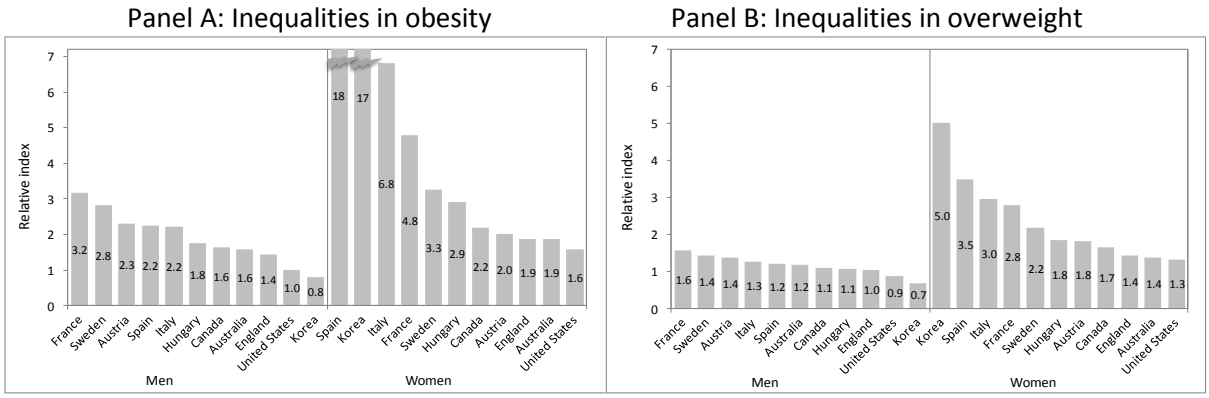
Absolute inequalities in overweight (Figure 1, Panel B) are larger than those in obesity for both genders. France displays the largest inequalities with a 20 percentage point difference in overweight rates between the least and the most educated men. Indexes for Korea and the US are both negative, although the education gradient for the US is not linear, with the highest rates observed in men with intermediate levels of education. The absolute index for overweight in women varies between 12.5 and 44.4, with the largest values for Spain, Korea and Hungary.

Figure 1. Absolute inequality indexes by education level



Relative inequalities vary substantially across countries (Figure 2). France, Sweden, Austria, Spain and Italy present the largest inequalities in obesity. The least educated women in Spain, Korea, Italy and France, are over four times as likely as the most educated ones to be obese. Relative inequalities in overweight (Figure 2, Panel B) are substantially smaller than those observed in obesity, but the ranking of countries is similar, with the largest inequalities observed in France, Sweden and Austria for men and in Korea, Spain and Italy for women.

Figure 2. Relative inequality indexes by education level

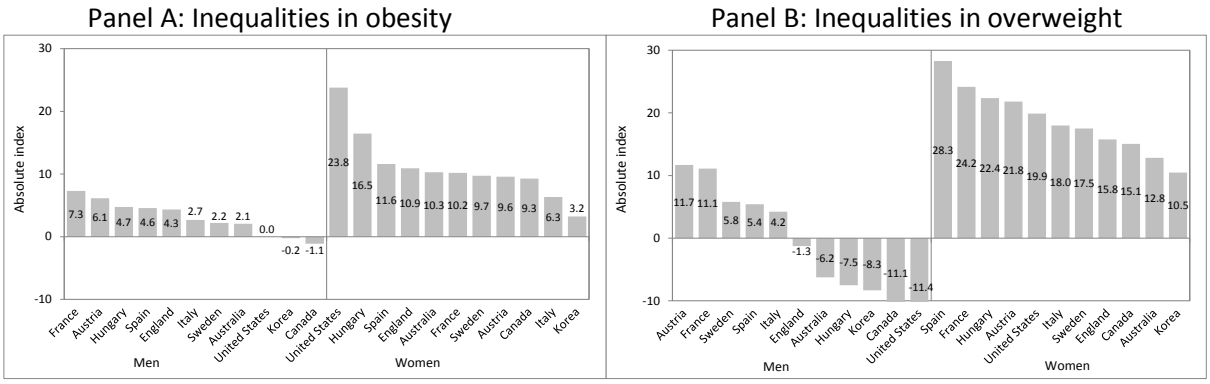


Note: On panel A, bars for Spain and Korea are truncated.

Inequalities by socio-economic status

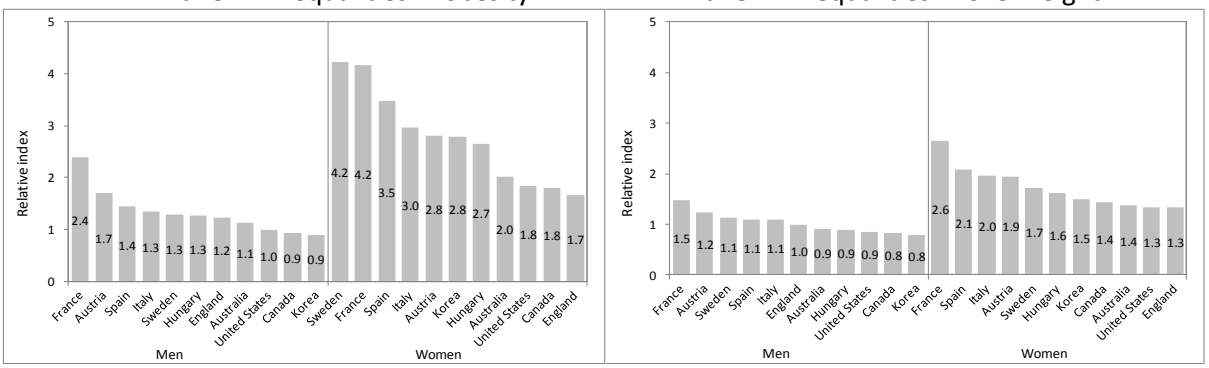
Figure 3 shows values of the absolute index of inequality in obesity. Absolute inequalities for men are largest in France and Austria, and they are virtually absent in the US, Canada, and Korea. For women, absolute inequalities are largest in the US and Hungary and smallest in Korea and Italy. Absolute inequalities in overweight are generally larger than in obesity, except for England and the US. The largest absolute inequalities in overweight are observed for men in Austria and France, and for women in Spain and France. However, large inverse (pro-poor) inequalities are observed in men in the US and Canada, while Korea, Hungary, Australia, and England have smaller pro-poor inequalities.

Figure 3. Absolute inequality indexes by socio-economic status



Men of the lowest socio-economic status are less than twice as likely to be obese as those at the opposite end of the social spectrum in all countries except France, where the relative index of inequality has a value of 2.4 (Figure 4). For women, the variation across countries in relative inequalities is wider, with France and Sweden topping the ranking. Relative inequalities in overweight follow a similar pattern to absolute inequalities, with relatively small gradients in different directions (pro-rich in some countries, pro-poor in others) in men, and larger inequalities in women, consistently in favour of those with a better socio-economic status.

Figure 4. Relative inequality indexes by socio-economic status



The degree of inequality appears to be inversely related to the overall prevalence of obesity and overweight. Countries with higher prevalence rates tend to have smaller inequalities (see age-

standardised prevalence rates in Supplementary File No.1). Men in France and Sweden have a low prevalence of obesity and the largest relative inequalities by education level. Similarly, men in France and Austria have the largest inequalities by socio-economic status. Similar patterns are observed for women.

Trends in inequalities across education levels

The availability of multiple health survey waves for most of the countries examined provided an opportunity to explore trends over time in social inequalities. Obesity and overweight rates for different social groups in eight countries (Australia, Canada, England, France, Italy, Korea, Spain and the US) since the early 1990s are displayed in a series of graphs in Supplementary File No.2. Rates are adjusted for demographic and socio-economic covariates. Trend lines for different groups are broadly parallel in most countries, suggesting that obesity and overweight rates have grown uniformly across the socio-economic spectrum. However, a small narrowing of inequalities by education level was observed in England, France, and Korea (interaction Wald-test significant at the 95% confidence level), and a small increase was observed for overweight in Italian men.

DISCUSSION

This paper provides evidence of significant social inequalities in obesity and overweight in 11 OECD countries. Disparities in obesity tend to be noticeably larger than disparities in overweight, both for men and for women. This is in line with the fact that the highest levels of BMI are often observed among the poorly educated and more generally among those in disadvantaged socio-economic circumstances. The size of inequalities varies across countries and between genders. Women in disadvantaged socio-economic groups are consistently more likely to be obese or overweight than more educated and affluent women. In men, smaller or no inequalities by education level were detected, while reverse (pro-poor) inequalities by income or occupation-based social class were found in several countries. The growth in obesity and overweight rates in the last 15 years in the countries examined has been broadly uniform across social groups, and inequalities have remained remarkably stable.

The findings reported here are consistent with previous reports that education-related inequalities in obesity are larger in women and in southern European countries.[11] Gender differences in degrees of inequality observed in this and other studies may be partly explained by a reverse causal effect linking

obesity with poor labour market outcomes in women more often than in men. In particular, Garcia Villar and Quintana-Domeque emphasise the potential role played by larger wage penalties suffered by women in the labour market.[10] Other possible explanations include the stronger two-way link between obesity and unemployment in women.[19-21] A further channel through which inequalities develop is marriage and partner selection, as there is evidence that obesity reduces the probability of marriage in women.[21] Similarly, evidence from a longitudinal study has shown that overweight women are more likely to be unmarried, have lower education and lower incomes, while these effects are weaker in men.[22] Men and women in disadvantaged socio-economic groups may also differ with regard to their patterns of physical activity. Low-paid jobs typically reserved to men tend to be more physically demanding than those more often taken up by women. Finally, the link between malnutrition in childhood and obesity in adulthood may be an additional reason since Case and Menendez (2007) showed on South African data that women who were nutritionally deprived as children are significantly more likely to be obese as adults, while men who were deprived as children face no greater risk.[23]

Gender differences in socio-economic gradients have important implications. Among other things, the higher prevalence of obesity in women belonging to disadvantaged socio-economic groups means that these women are more likely to give birth and raise children who will themselves be overweight or obese, and in turn will have fewer chances of moving up the social ladder, perpetuating the link between obesity and socio-economic disadvantage. A number of studies gave evidence on mother to child transmission of obesity.[24] Acting on the mechanisms that make individuals who are poorly educated and in disadvantaged socio-economic circumstances so vulnerable to obesity, and those at the other end of the socio-economic spectrum much more able to handle obesogenic environments, is of great importance not just as a way of redressing existing inequalities, but also because of its potential effect on overall social welfare.

Beyond the gender difference, it is observed that education-related inequality indexes are higher than socio-economic inequality indexes. Similarly, Costa-Font and Gil (2008) found that formal educational captures a large share of the income-related inequality in obesity. The authors suggest as a possible explanation that the effects of unobservable factors like knowledge and social environment may possibly pass through education. [25] More educated people have a better knowledge on health risks, in particular, the risk of obesity, and so, they are less affected by obesity problem.[26] The effects of education on obesity are strengthened by social interactions with similarly educated peers, as there is evidence that health-related behaviours often spread through social networks.[27] In addition, another

possible explanation is that the education effect on obesity may reflect unobservable factors like time preference.[25] There is plausible evidence that time preferences based on a higher discount rate lead to less exercise and greater caloric intake.[28]

It is more difficult to find an explanation for the different degrees of inequality observed across countries. It appears clearly that countries with a higher overall prevalence of obesity and overweight tend to have milder inequalities (but not without exceptions – such as Spain), suggesting that higher socio-economic groups may have caught up with others in terms of obesity and overweight, as overall rates increased. However, our analysis of trends over time in inequalities clearly shows that obesity and overweight have grown in a similar way in all social groups. It is possible that inequalities may have narrowed in countries with a higher prevalence at an earlier stage of the obesity epidemic, when rates were growing faster than they are now. But longer time series are needed to test this hypothesis.

Extensive efforts were made to overcome data heterogeneities, over time and across countries, particularly in relation to education, income and occupation-based social class variables. One remaining issue is the heterogeneous nature of BMI measures used to assess obesity rates (measured in some countries, self-reported in others). Obese and overweight people tend to under-estimate self-reported weight.[29-31] To address this problem, algorithms have been proposed to adjust BMI values for self-report bias, based on US data from the National Health and Nutrition Examination Surveys (NHANES).[32-33] Unfortunately similar algorithms are not available for other countries, therefore this approach could not be used here. However, assuming a broadly consistent reporting bias across socio-economic groups, the absolute inequalities index may be under-estimated but the relative index should not be affected. A second remaining source of heterogeneity is that socio-economic status was determined on the basis of household income in four countries (Australia, Canada, Korea and the US) and occupation-based social class in the rest. Whether this may contribute to explaining the positive correlation between socio-economic status and overweight observed in the former four countries for men, as well as in Canada and Korea for obesity, is impossible to determine on the basis of existing data, although recent studies on the relationship between income and BMI lend some support to these findings.[9-10]

REFERENCES

1 World Health Organisation expert consultation. Appropriate Body-Mass Index for Asian Populations and its Implications for Policy and Intervention Strategies. Lancet 2004;363:157-163.

2 OECD/ Sassi F, Devaux M, Cecchini M, Rusticelli E. The Obesity Epidemic: Analysis of Past and Future Trends in Selected OECD Countries. *OECD Health Working Papers No. 45*, Directorate for Employment, Labour and Social Affairs, OECD, Paris. 2009.

3 Cutler D, Lleras-Muney A. Education and Health: Evaluating Theories and Evidence. *NBER Working Paper No.12352*. 2006. www.nber.org/papers/w12352 (accessed 18 Jan 2010)

4 Jacobsen BK, Nilsen H. High education is associated with low fat and high fibre, beta-carotene and vitamin C – Computation of nutrient intake based on a short food frequency questionnaire in 17,265 men and women in the Tromsø Study. *Norsk Epidemiologi* 2000;10(1):57-62.

5 Webbink D, Martin NG, Visscher PM. Does Education Reduce the Probability of Being Overweight?. *CPB Discussion Papers 102*, CPB Netherlands Bureau for Economic Policy Analysis. 2008.

6 Lobstein T, Jackson Leach R. Tackling Obesities: Future choices – International Comparisons of Obesity Trends, Determinants and Responses – Evidence Review, Foresight, Government Office of the Chief Scientist. 2007. http://www.foresight.gov.uk (accessed 18 Jan 2010)

7 Branca F, Nikogosian H, Lobstein T. Socioeconomic inequality in obesity in Europe: issues and policy implications. In: Branca F, Nikogosian H, Lobstein T, editors. The Challenge of Obesity in the WHO European Region and the Strategies for Response. Copenhagen, WHO Regional Office for Europe. 2007:152-173.

8 Wardle J, Waller J, Jarvis MJ. Sex Differences in the Association of Socioeconomic Status with Obesity. *Am J Public Health* 2002;92:1299–1304.

9 de Saint Pol, T. Evolution of obesity by social status in France, 1981-2003. *Econ Hum Biol* 2009;7(3):398-404.

10 Garcia Villar J, Quintana-Domeque C. Income and body mass index in Europe. *Econ Hum Biol* 2009;7(1);73-83.

11 Mackenbach JP, Stirbu I, Roskam AR, et al. Socioeconomic Inequalities in Health in 22 European Countries. *N Engl J Med* 2008;358(23):2468-81.

12 De Irala-Estévez J, Groth M, Johansson L, Oltersdorf U, Prättälä R, Martínez-González MA. A systematic review of socio-economic differences in food habits in Europe: consumption of fruit and vegetables. *Eur J Clin Nutr* 2000;54(9):706-714.

13 UNESCO Institute for Statistics website consulted on October 15, 2010 http://www.unesco.org/education/information/nfsunesco/doc/isced_1997.htm

14 International Labour Organization website consulted on October 15, 2010 http://www.ilo.org/public/english/bureau/stat/isco/isco88/index.htm

15 UK National Statistics website consulted on October 15, 2010 http://www.statistics.gov.uk/methods_quality/ns_sec/downloads/NS-SEC_User.pdf

16 Wagstaff A, Paci P, van Doorslaer E. On the Measurement of Inequalities in Health. *Soc Sci Med* 1991;33(5):545-57.

17 Pamuk ER. Social Class and Inequality in Mortality from 1921 to 1972 in England and Wales. *Popul Stud (Camb)* 1985;39(1):17-31.

18 Mackenbach JP, Kunst AE. Measuring the Magnitude of Socio-Economic Inequalities in Health: an Overview of Available Measures Illustrated with Two Examples from Europe. *Soc Sci Med* 1997;44(6):757-771.

19 Morris S. Body Mass Index and Occupational Attainment. *J Health Econ* 2006;25:347-364.

20 Härkönen J. Labour force dynamics and the obesity gap in female unemployment in Finland. *Research on Finnish Society* 2007;1:3–15.

21 Conley D, Glauber R. Gender, Body Mass, and Socioeconomic Status: New Evidence from the PSID. *Adv Health Econ Health Serv Res* 2007;17:253-275.

22 Gortmaker SL, Must A, Perrin JM, Sobol AM, Dietz WH. Social and Economic Consequences of Overweight in Adolescence and Young Adulthood. *N Engl J Med* 1993;329(14):1008-12.

23 Case A, Menendez A. Sex Differences in Obesity Rates in Poor Countries: Evidence from South Africa. *NBER Working Paper No. 13541*. 2007. http://www.nber.org/papers/w13541 (accessed 18 Jan 2010).

24 Whitaker RC, Wright JA, Pepe MS, Seidel KD, Dietz WH. Predicting obesity in young adulthood from childhood and parental obesity. *N Engl J Med* 1997;337(13):869-73.

25 Costa-Font J, Gil J. What lies behind socio-economic inequalities in obesity in Spain? A decomposition approach. *Food Policy* 2008;33:61–73.

26 Kan K, Tsai WD. Obesity and risk knowledge. *Journal of Health Economics* 2004;23:907–934.

27 Sassi F. Chapter 4. How does obesity spread? In: Obesity and the Economics of Prevention: Fit not Fat. OECD Publishing. Paris, 2010:115-140.

28 Komlos J, Smith PK, Bogin B. Obesity and the Rate of Time Preference: Is there a Connection? *Discussion Papers in Economics 60*, University of Munich, Department of Economics 2003.

29 Shields M, Connor Gorber S, Tremblay M S. Estimates of obesity based on self-report versus direct measures. *Health Reports* 2008;19(2):61-76.

30 Elgar F J, Roberts C, Tudor-Smith C, Moore L. Validity of self-reported height and weight and predictors of bias in adolescents. *Journal of Adolescent Health* 2005;37:371-375.

31 Cronin P, Haas M, Savage E, Vu M. Misperceptions of Body Mass: Analysis of NSW Health Survey 2003. *CHERE Working Paper 2009/7*. October 2009.

32 Cawley, J. Body Weight and Women's Labor Market Outcomes. *NBER Working Paper No. 7841*. 2000. http://www.nber.org/papers/w7841 (accessed 17 Oct 2010).

33 Lakdawalla D, Philipson T. The Growth of Obesity and Technological Change: A Theoretical and Empirical Examination. NBER Working Paper No. 8946. 2002. http://www.nber.org/papers/w8946 (accessed 17 Oct 2010).

ANNEXES

Supplementary File No.1- Table: Description of the data

Country	Survey name	Years	Number of individuals aged 15-64 with data on height and weight	Obesity rates in last year		Overweight rates in last year	
				Men	Women	Men	Women
Australia	National Health surveys	1995, 2001 and 2005	80,215	18.00%	16.00%	59.50%	42.10%
Austria	Mikrozensus + Health Interview Survey	1999 and 2007	42,059	10.90%	10.70%	50.80%	34.00%
Canada	National Health Population Survey +Canadian Community Health Survey	1994-95, 2000-01, 2003, 2005	266,782	17.20%	15.80%	54.20%	39.60%
England	Health Survey for England	Annually from 1995 to 2007	114,807	21.60%	22.50%	60.70%	52.20%
France	Enquête Santé et Protection Sociale	1995, 1996, 1997, 1998, 2000, 2002, 2004, 2006	67,780	9.90%	9.90%	43.50%	29.90%
Hungary	National Health Interview survey	2000, 2003	8,543	18.10%	16.90%	56.60%	43.90%
Italy	Condizioni di Salute	1994-95, 2000, 2003 and 2005	215,664	8.90%	6.90%	46.90%	26.70%
Korea	Korean National Health and Nutrition Examination Survey	1998, 2001 and 2005	19,113	3.50%	3.50%	34.60%	26.10%
Spain	Encuesta nacional de salud de España	1995, 1997, 2001 and 2003	39,826	11.50%	10.50%	53.20%	34.50%
Sweden	Living Conditions Survey	2000	4,350	7.80%	7.40%	43.70%	30.10%
United States	National Health and Nutrition Examination Survey	1999-00, 2001-02, 2003-04, 2005-06, 2007-08	24,243	29.90%	34.20%	67.70%	60.70%

Note: Overweight rates include obesity. Rates were age-standardised using the 2005 OECD standard population.

Supplementary File No.2 - Trends in obesity and overweight rates by level of education

As data for Austria, Hungary and Sweden cover one or two survey years, they were not taken into account in the analysis of trends.

Inequalities over time were first analysed graphically. In most countries, trends in obesity and overweight by level of education are broadly parallel. However it is worth noting exceptions for men in England and in Korea, where inequalities appear to have decreased. Additionally, an overall interaction Wald-test for the significance of the interaction term between time and education reveals that the interaction term is significant in England and Italy for overweight in men, in Italy for obesity in women and in England and France for obesity and overweight in women. In England, results suggest a reduction in inequalities across education levels. (Figures A3-A5 Panel A). In Italy, inequalities in overweight for men appear to increase over time, but at a small degree (Figure A7 Panel A). England and France display a small reduction in inequalities in women since the gap in obesity and overweight rates between those with intermediate and those with low education decreased (Figures A3-A5 and Figure A6 Panel B).

Reported rates are estimates from logistic regression models adjusted for a range of demographic and socio-economic covariates (age, smoking status, occupation status, marital status, education level, socio-economic condition, and ethnicity for England and the US). Rates are relative to people aged 40, non smoking, working and married. Darker lines represent the lowest level of education. Estimated rates of obesity and overweight controlled for socio-demographic covariates, are displayed for men and women separately. Moreover, results were broken down by ethnicity for England and the US as the data provide that information.

Figure A1: Trends in Australia

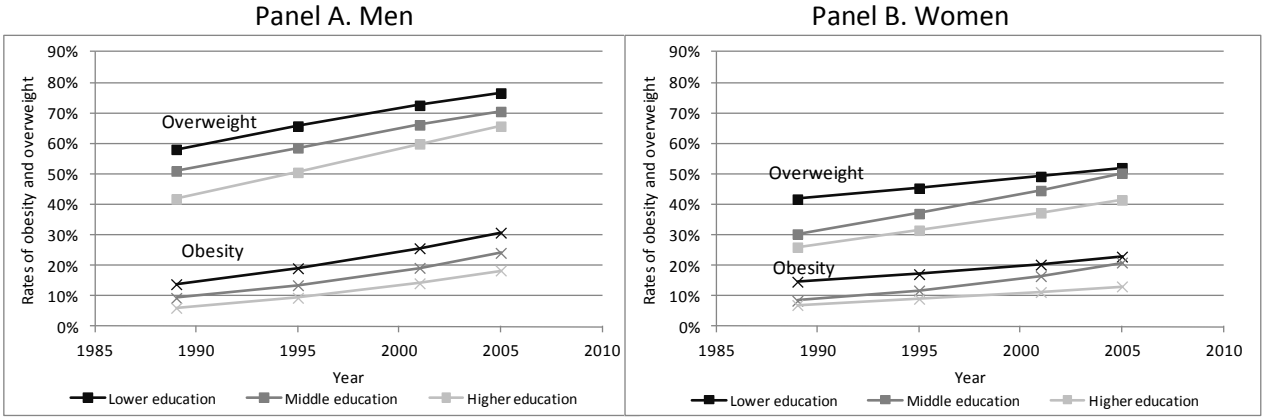


Figure A2: Trends in Canada

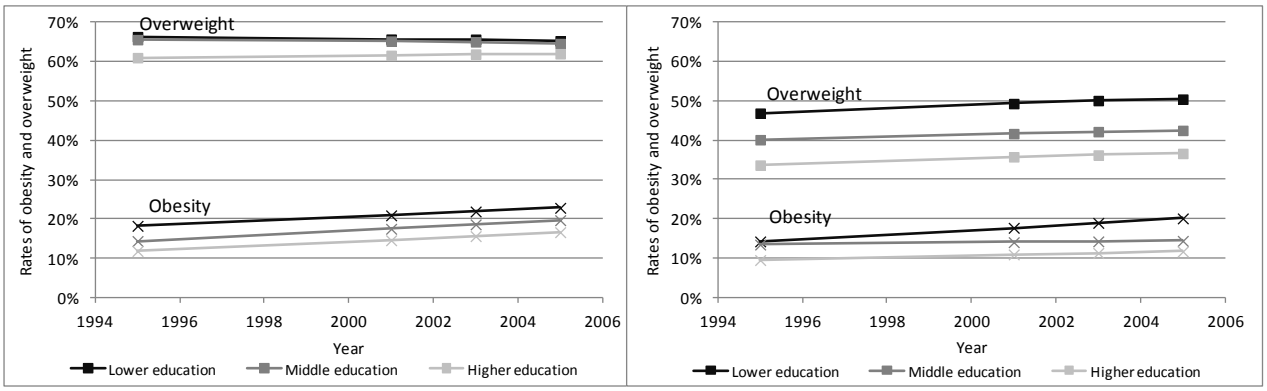


Figure A3: Trends in England, in White population

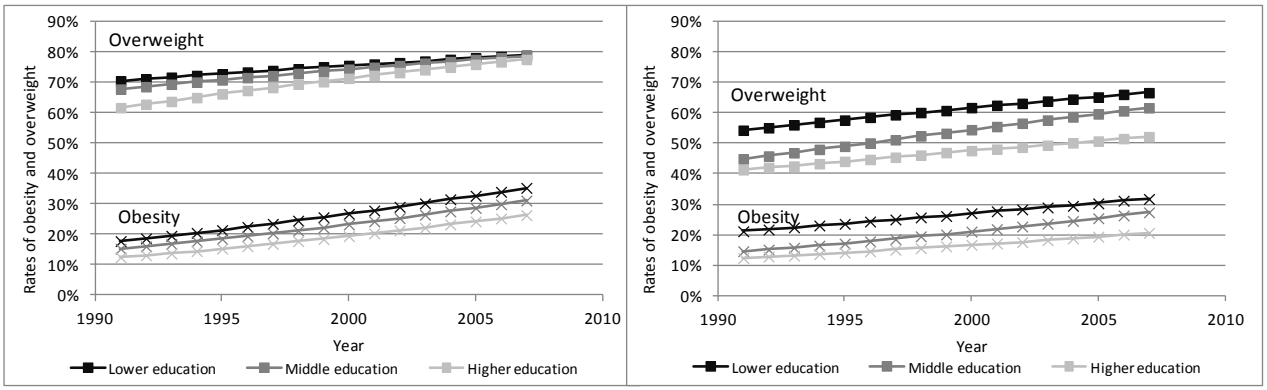
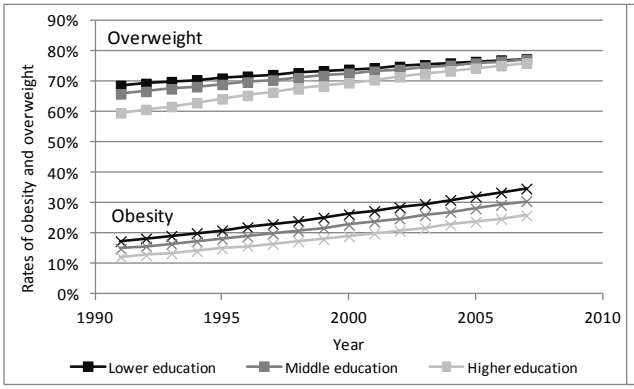


Figure A4: Trends in England, in Black population

Panel A. Men



Panel B. Women

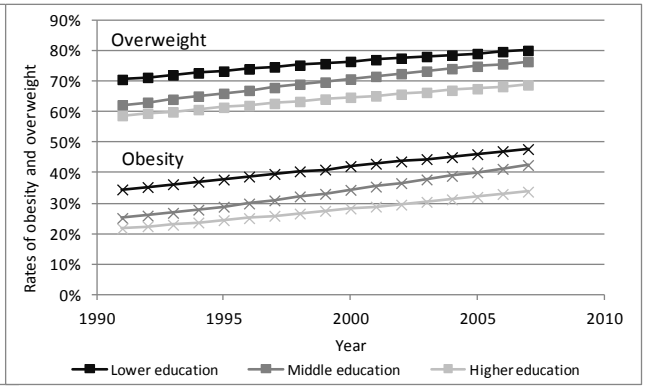
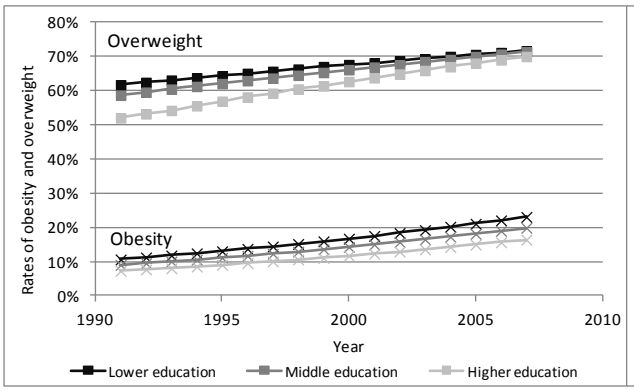


Figure A5: Trends in England, in Asian population

Panel A. Men



Panel B. Women

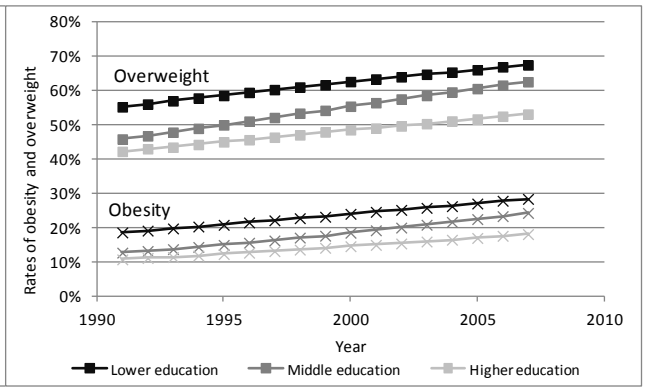
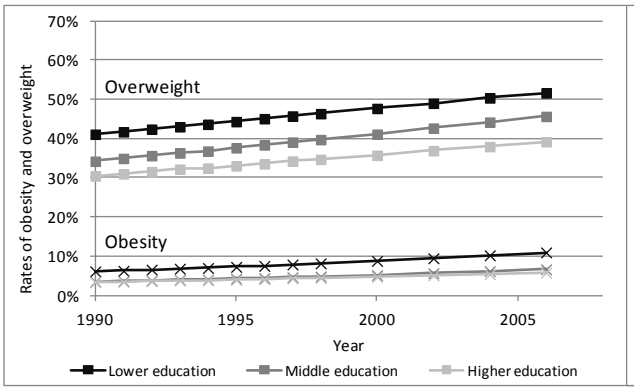


Figure A6: Trends in France

Panel A. Men



Panel B. Women

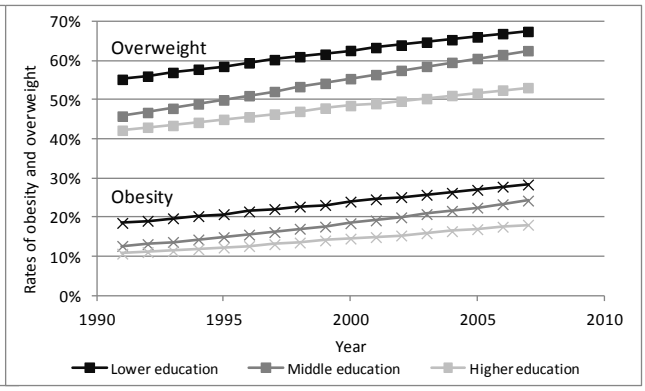


Figure A7: Trends in Italy

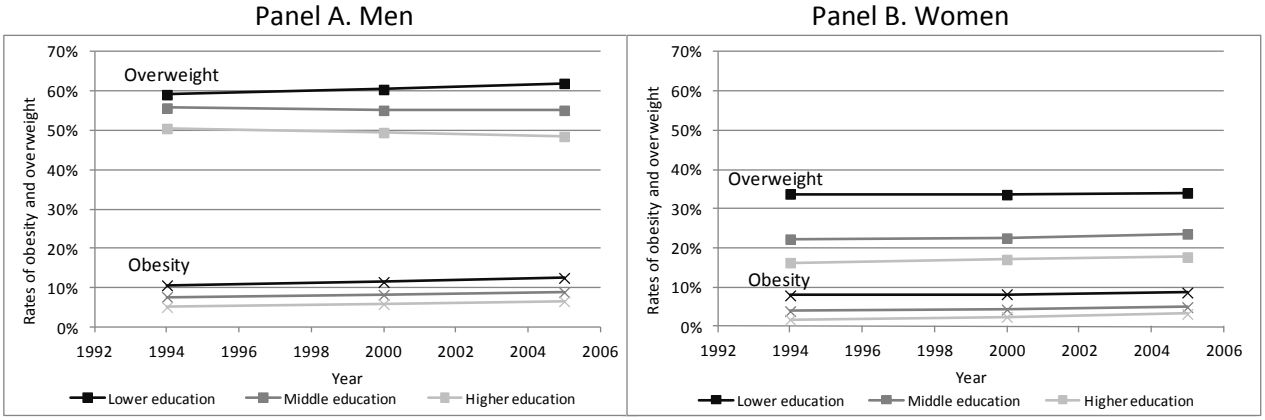


Figure A8: Trends in Korea

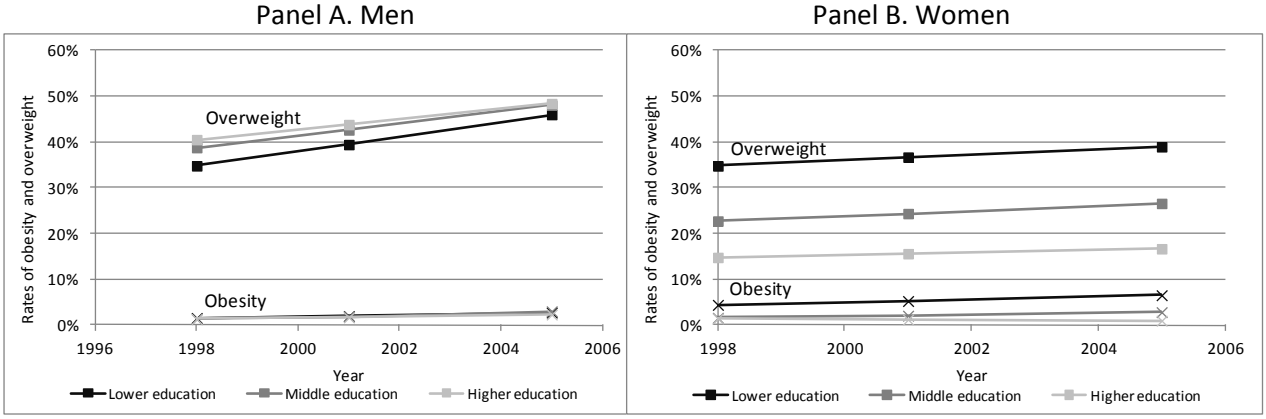


Figure A9: Trends in Spain

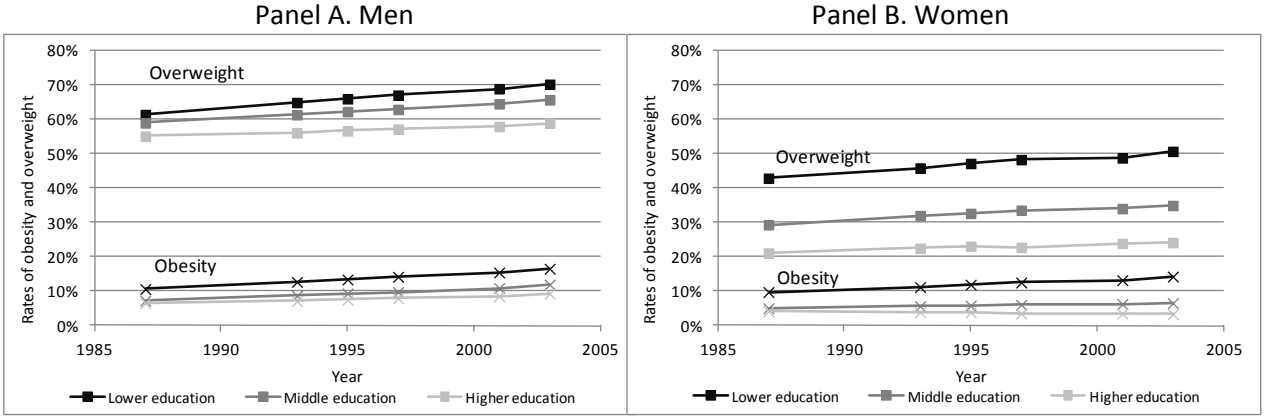


Figure A10: Trends in the US, in White population

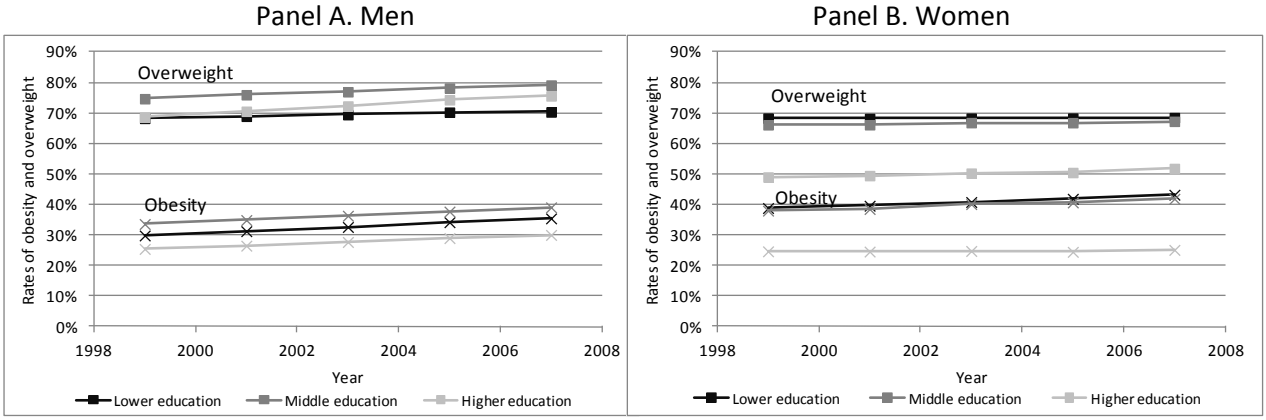


Figure A11: Trends in the US, in Black population

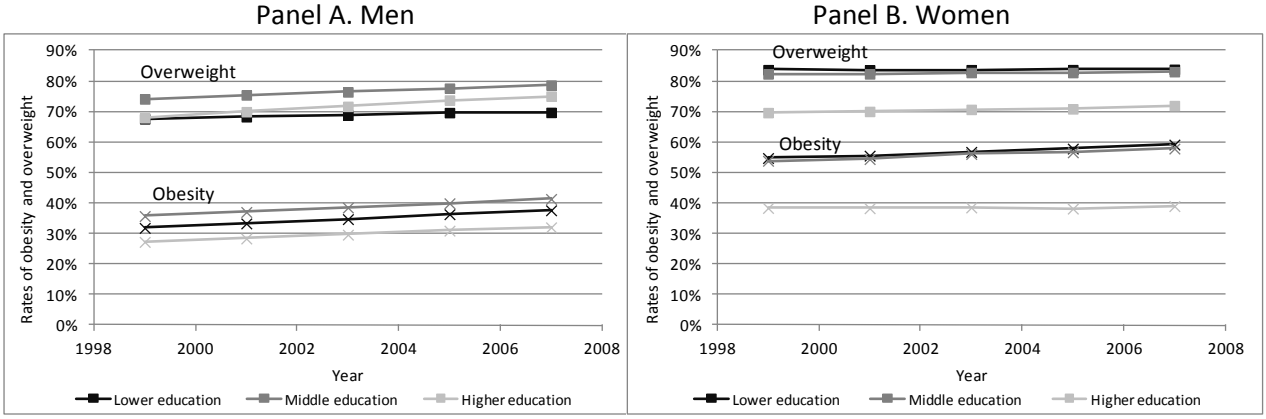


Figure A12: Trends in the US, in Mexican population

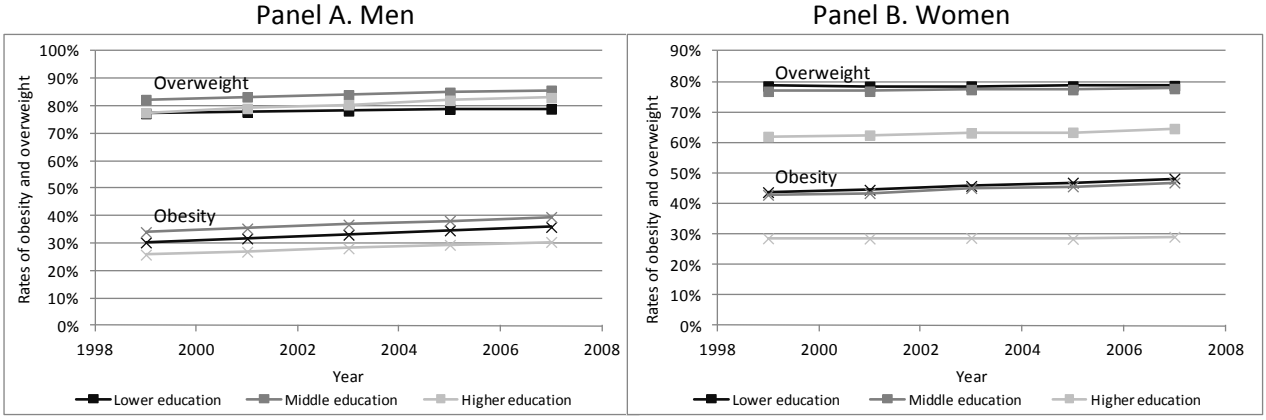
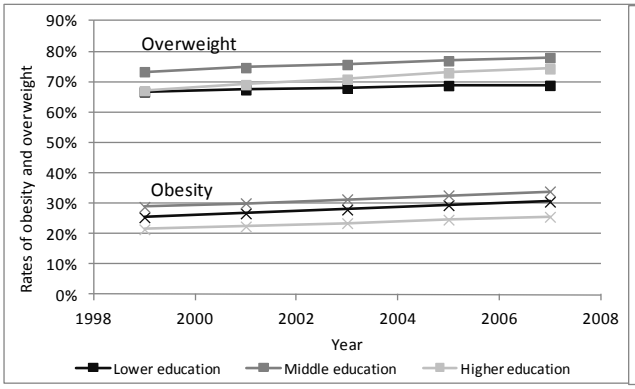
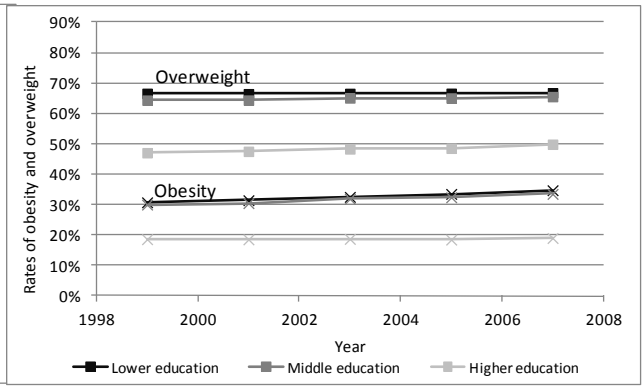


Figure A13: Trends in the US, in other ethnic population group

Panel A. Men



Panel B. Women



Exploring the Relationship between Education and Obesity

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ABSTRACT

An epidemic of obesity has been developing in virtually all OECD countries over the last 30 years. Existing evidence provides a strong suggestion that such an epidemic has affected certain social groups more than others. In particular, a better education appears to be associated with a lower likelihood of obesity, especially among women. This paper sheds light on the nature and the strength of the correlation between education and obesity. Analyses of health survey data from Australia, Canada, England, France, and Korea were undertaken with the aim of exploring this relationship. Social gradients in obesity were assessed across the entire education spectrum, overall and in different population sub-groups. Furthermore, investigations testing for mediation effects and for the causal nature of the links observed were undertaken to better understand the underlying mechanisms of the relationship between education and obesity.

Introduction

Overweight and obesity rates have been increasing sharply over recent decades in all industrialised countries, as well as in many lower income countries. The rise in obesity has reached epidemic proportions, with over one billion adults worldwide estimated to be overweight and at least three hundred million of those considered to be clinically obese (WHO, 2003). The circumstances in which people have been leading their lives over the past 20-30 years, including physical, social and economic environments, have exerted powerful influences on their overall calorie intake, on the composition of their diets and on the frequency and intensity of physical activity at work, at home and during leisure time. On the other hand, changing individual attitudes, reflecting the long-term influences of improved education and socio-economic status (SES) have countered to some extent environmental influences.

Many OECD countries have been concerned not only about the pace of the increase in overweight and obesity, but also about inequalities in their distribution across social groups, particularly by level of education, socio-economic status and ethnic background. Inequalities across social groups appear to be particularly large in women (Wardle *et al*., 2002; Branca *et al*., 2007). Acting on the mechanisms that make individuals who are poorly educated and in disadvantaged socio-economic circumstances so vulnerable to obesity, and those at the other end of the socio-economic spectrum much more able to handle *obesogenic* environments, is of great importance not just as a way of redressing existing inequalities, but also because of its potential effect on overall social welfare. The current distribution of obesity appears particularly undesirable, as it is likely to perpetuate the vicious circle linking obesity and disadvantage by intergenerational transmission.

Research has produced ample evidence of the individual labour market returns of education. Economists have shown much interest in the estimation of the causal effect of education on wages and economic growth (see Card 2001, for a comprehensive review of the literature) but only recently has work begun to investigate the non–monetary returns of schooling (see McMahon, 2004 for a review). Empirical studies, for example, suggest that education has a positive impact on health and well-being (Wolfe and Haveman 2002; Lleras-Muney 2005), particularly in poorer countries (Cutler and Lleras-Muney, 2006), reduces crime (Lochner and Moretti 2004) and water and air pollution (Appiah and McMahon 2002). The finding that education has positive externalities provides a rationale for government intervention.

However, the causal nature of the link between education and health is still subject to a certain degree of scrutiny, and the precise mechanisms through which education may affect health are not yet fully understood. Lifestyles may be one of the keys to understanding such relationship, as they are often significantly influenced by education and, at the same time, they contribute to health and longevity by affecting the probability of developing a wide range of diseases. Obesity is a close marker of important aspects of individual lifestyles, such as diet and physical activity, and is also an important risk factor for major chronic diseases, such as diabetes, heart disease, stroke and certain cancers. Obesity is also associated with negative labour market outcomes, in term of both wages and employment, particularly for women (Cawley, 2004; Brunello *et al*., 2006).

The aim of this paper is to provide new evidence concerning the relationship between education and obesity and contribute to understand the nature of such relationship and its implications for health and education policy. The empirical analyses on education and obesity undertaken by the OECD focus on four countries: Australia, Canada, England and Korea. Data from health surveys regularly undertaken in the four countries were used in a range of analyses, in pursuit of the following specific objectives:

a) to explore the correlation between body mass index, and obesity, on one hand, and formal education, expressed in terms of years spent in full-time education, on the other, controlling for possible confounding factors. The main goal of this analysis is to determine whether the intensity of the relationship between education and obesity is constant, or whether it shows increasing or decreasing strength at either end of the education spectrum.

b) to assess the extent to which the correlations identified may reflect the influences of factors associated with individual education, such as socio-economic status and the level of education of household members.

c) to assess the extent to which the correlations identified may reflect causal links between education and obesity.

d) to explore what conceptual model of the role of education as a determinant of health is most consistently supported by the findings concerning the correlation between obesity and aspects of individual and group education.

BOX 1: Data description

The analyses reported in this paper are based on individual-level national health surveys covering four OECD countries: Australia, Canada, England and Korea. Data sources include the Australian National Health Survey (NHS) 1989-2005, the Canadian National Population Health Survey – cross-section (NPHS) and the Canadian Community Health Survey (CCHS) 1995 -2005, the Health Survey for England (HSE) 1991-2005 and the Korean National Health and Nutrition Examination Survey (KNHANES) 1998-2005. All available survey waves were pooled for each survey. Since the focus of the analyses was the relationship between obesity and education, survey samples were restricted to individuals in the age range 25-64 who were supposed to have completed their full time education, and for whom the body mass index is a useful proxy for health risk. Body mass index (BMI) was calculated as weight in kilograms divided by square height in meters. Obesity and overweight status were then derived as BMI greater than 30 and 25.

The analyses were conducted by applying the same models to all countries' data, in order to facilitate comparisons across countries. However, differences in data and survey methods sometimes make it difficult to achieve complete consistency. For instance, data on height and weight were measured by examination in England and Korea while they were self-reported in the other two countries. The education variable was obviously a critical one, and the format of this variable varied across countries. We created a variable reflecting the numbers of years spent by each individual in full-time education using all the information available in each dataset on years of schooling and educational attainment. For consistency, we grouped together individuals with no education and those with the lowest level of education, as these two groups were not always separated in the available datasets. A certain degree of heterogeneity was also present in relation to the socio-economic status (SES) variable, as occupation-based social class was reported in the English data, while equivalised household income was available in Australia, Canada and Korea. Individuals were allocated to income quintiles in Australia and Korea, and to income groups based on fixed income ranges in Canada. Finally, an ethnicity variable was available in England, while proxies were used in Canada (minority status) and Australia (migrant status). No such variable was available in Korea. Tables of descriptive statistics are presented in Annex 1.

Existing evidence on the relationship between education and obesity

The existing evidence concerning the relationship between education and obesity is relatively limited, as the main focus of most research has been more broadly on the links between socio-economic factors and health status, or longevity, with a smaller number of studies focusing on lifestyles and on obesity in particular. The evidence available, covering a number of OECD countries, generally shows strong associations between education and obesity. However, there have been only few studies that have investigated the causal effects of education on obesity, and these studies have reported mixed results.

Cutler and Lleras-Muney (2006) found that those with more years of schooling are less likely to smoke, drink a lot, to be overweight or obese or to use illegal drugs. Similarly, the better educated are more likely to exercise and to obtain preventive care such as flu shots, vaccines, mammograms, pap smears and colonoscopies. They also found the relationship between education and health appears to be non-linear for obesity, with increasing effects of additional years of schooling. A review by Grossman and Kaestner concluded that years of formal schooling is the most important correlate of good health (Grossman *et al.*, 1997). Cross-sectional estimates from a study of twins conducted by Webbink *et al*. (2008), also confirms the negative relationship between education and the probability of being overweight. By looking at differences between the sexes within a study of socio-economic factors and obesity, Yoon *et al*. (2006) found that income, rather than education, had a greater effect on BMI and waist circumference in men, whereas higher levels of education for women resulted in lower BMI and waist circumference.

The correlation between education and health may reflect three possible types of relationships: (a) a causal link running from increased education to improved health, (b) a reverse causal link, indicating that better health leads to greater education; or (c) an absence of a causal relationship between education and health, which appear to be correlated because of possible unobserved factors affecting both health (or obesity) and education in the same direction. The three pathways are not mutually exclusive, of course, and some combination of the three is likely to provide the most plausible explanation of the strong correlations consistently found across countries between education and health, or obesity. Cutler and Lleras-Muney (2006) argue that children in poor health obtain less schooling and because of this they are also more likely to be unhealthy adults. Similarly, evidence on longitudinal data shows that becoming overweight during the first 4 years in school is a significant risk factor for adverse school outcomes in girls (Datar and Sturm, 2006). Unobserved factors possibly contributing to the third

pathway identified may include family background, genetic traits or other individual differences, such as ability to delay gratification. These factors may explain why the more educated are also healthier. Cutler and Lleras-Muney (2006) found that even controlling for some of these factors, the effect of education on health generally remains large and significant. Although there is evidence to support the hypothesis that the direction of causality is from more schooling to better health (Grossman, 2000), when overall health status or longevity are the outcomes of interest, there are few studies shedding light on the causal nature of the relationship between education and obesity specifically. Results from Lundborg (2008) suggest that a causal effect of education on health exists, but found no evidence that lifestyle factors such as smoking and obesity contribute to the health/education gradient. Natural experiments where policy changes are implemented that directly affect the number of years of mandatory schooling, can provide an indication of the causal nature of the link between education and obesity. Arendt (2005) used changes in compulsory education laws in Denmark and found inconclusive results regarding the effect of education on BMI. However, Spasojevic, (2003) using a similar estimation strategy for Sweden found that additional years of education have a causal effect on maintaining a healthy body mass index. Clark and Royer (2008) focused on an educational reform implemented in England in 1947, which increased the minimum compulsory schooling age in the country, from 14 to 15. They found that cohorts affected by the law display only slightly improved long-run health outcomes and their findings did not support a causal link between education and obesity. Brunello *et al.* (2009) used compulsory school reforms implemented in European countries after the II World War to investigate the causal effect of education on the BMI and the incidence of overweight and obesity among European females. They showed that years of schooling have a protective effect on BMI. On US data, Grabner (2009) used the variation caused by state-specific compulsory schooling laws between 1914 and 1978 as an instrument for education, and found a strong and statistically significant negative effect of additional schooling on BMI, effect especially pronounced on females.

Michael Grossman's demand for health model, developed in the 1980s, hypothesised that "schooling raises a person's knowledge about the production relationship and therefore increases his or her ability to select a healthy diet, avoid unhealthy habits and make efficient use of medical care" (Kemna, 1987). Educated individuals make better use of health related information than those who are less educated. Education provides individuals with better access to information and improved critical thinking skills. Speakman *et al*. (2005) hypothesised that the lack of education about energy contents of foods may contribute to the effects of social class on obesity. Results from their study show that on average, non-obese individuals in the lower social class group have better food knowledge than those

who are obese in the same group. However non-obese subjects in all groups overestimate food energy in alcoholic beverages and snack foods indicating poorer knowledge of the energy content of these foods. Lack of information could also affect one's own perception about their body mass. Research has shown that over time more overweight individuals are under-perceiving their body mass compared to people with normal weight (Haas, 2008). It is possible that more highly educated people have the knowledge to develop healthy lifestyles and have more awareness of the health risks associated with being obese (Yoon, 2006). The more educated are more likely to choose healthy lifestyles; however, it has been shown that the highly educated choose healthier behaviours than individuals who are highly knowledgeable about the consequences of those behaviours (Kenkel, 1991). This could indicate that the effect of education on obesity is driven by different mechanisms, and not just by information and knowledge about healthy lifestyles.

Exploring the link between education and obesity is important, as this may lead to the development of appropriate education-based policies to counteract recent trends in obesity and related chronic diseases. For example, if the findings reported by Cutler and Lleras-Muney (2006) showing increased effects of additional years of schooling for those who are better educated were confirmed by further analyses, these would provide support for education policies aimed at promoting higher education, as these would produce greater health returns.

Policy and institutional environment

Policies aimed at counteracting the negative effects of obesity through the education system can be of two main types: policies focusing on the educational environment, aimed at promoting healthier lifestyles by exposing children to healthier environments and by providing health education; and policies aimed at encouraging higher levels of general education. Although the relationship between years of schooling, or educational attainment, and health outcomes is well established, most of the policies encountered to improve health by promoting lifestyle changes have focused on educating the population about healthier lifestyles as opposed to providing more general education. Each of the four countries examined in this study have implemented policies to strengthen "healthy living" education within schools, with the aim of achieving better health outcomes.

Australia has developed National Goals for Schooling in the Twenty-First Century, to which authorities across governmental jurisdictions refer to provide young Australians with the best possible educational outcomes and improve the quality of schooling nationally. The Active School Curriculum/ Building a Healthy Active Australia through the Department of Health and Ageing aims to provide young people with the skills to embrace an active lifestyle by introducing them to a range of physical activities. All state and territory governments and non-government education authorities have committed to providing in their curriculum at least two hours of physical activity each school week for primary and junior secondary school children under the Schools Assistance Act 2004. Also, the Australian Social Inclusion Agenda of the Australian Labor Party recommended that more young people from disadvantaged backgrounds complete twelve years of schooling and go on to further education and training.

In Canada, due to the vast geographical dispersion of the population, many policies relating to health and education are conducted at the Provincial/Territorial level. Nova Scotia, for example, implemented the Annapolis Valley Health Promoting Schools programme in seven elementary schools, with preliminary results indicating that those schools which implemented the programme had significantly lower rates of overweight and obese students. The British Columbia Children's Hospital and the University of British Columbia implemented a programme called "Healthy Buddies" to empower elementary school children to live healthier lives by providing them with knowledge about health and physical activity. Results from the programme have shown that students had an increase in their healthy-living knowledge and BMI and less weight gain than students who were not in the programme. In Quebec the "Take care of your health!" programme delivered by ACTI-MENU (a health promotion organization) aimed to provide employees with information and support risk factor reduction. Evaluation of the programme revealed that participants were more likely to report more frequent physical activity and better nutritional practices and absenteeism declined by 28% and turnover by 54%.

As part of the National Health Promotion Act, Korea established national policies aimed at enhancing people's health through health education, disease prevention, nutrition improvement and the practice of healthy lifestyles. The Health Plan 2010 aims at improving the nutritional status of the population and a part of this was the revision and dissemination of dietary guidelines, enforcing mandatory nutrition labelling and providing information to groups deemed vulnerable such as the elderly and young children. Part of this strategy is to develop the plan in line with educational, political, economic and organizational means. The Health Plan 2010 includes activities focusing on the

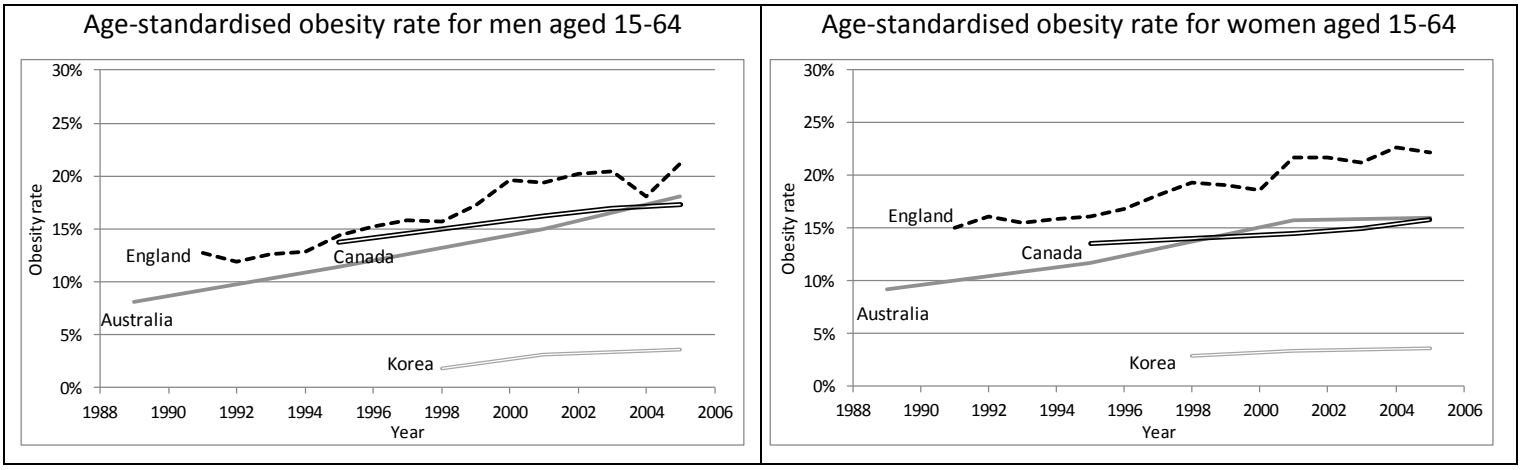
development of nutritious diets, development of obesity prevention and management programs and physical activity campaigns.

'Healthy Weight, Healthy Lives: A Cross-Government Strategy for England' targets children for healthy growth and healthy weight. Funded through the Department of Health, this strategy aims to reduce the proportion of overweight and obese children back to the levels found in 2000 by 2020. The NHS (National Health Service) has strategies aimed at offering public advice and support to those who already have weight problems through weight management programmes, NHS websites, as well as by developing the ability of health service staff to deal with issues of excess weight. Additionally, strategies exist in England to combat obesity through the promotion of healthier food choices, by limiting food advertising to children and working with the food industry to reduce salt, sugar and fat in foods; as well as strategies such as "Walking into Health" to build physical activity into the lives of the whole population and "Active England" aimed at promoting non-sport physical activity.

General trends in obesity in the four countries

The distribution of BMI in the four countries concerned has been shifting in a characteristic fashion over the past few decades, as illustrated in Sassi *et al*., 2009. In particular, as in most OECD countries, a sizable share of the normal weight population has been progressively gaining weight, moving towards the pre-obese category first, then progressively towards obesity and, in some cases, morbid obesity (BMI>40). A visible increase in the percentage of the population that is obese was recorded for both men and women, across all four countries (Figure 1). However, a significant difference in trends between genders is observed in Korea, where the relative distribution of females over the BMI categories remained relatively stable between 1998 and 2005, while a 10% decrease in the normal weight category was observed in men, followed by a 9% increase in the pre-obese category and a 2% increase in the obese category. On the other hand, in 2005 Korea had only 4% of its population obese, on average, compared to 25% in England, 18% in Australia and 17% in Canada. In the latter three countries the percentage of overweight men is significantly higher than that of women. In Canada, the majority of men were overweight in all survey years, and the same has been true in England since 1995.

Figure 1. Trends in age-standardised obesity rates in Australia, Canada, England and Korea.



Source: Authors' estimates using 2005 OECD standard population.

BOX 2: Methods

Differences in obesity rates among population groups with different levels of education were first analysed using logistic regression models controlling for a range of covariates, including gender, age, ethnicity, SES and survey year (Figure 2 and Annex 2). An interaction term between education and gender was also included in the regression model for the purpose of assessing differences between the two genders in the relationship between education and obesity (Figures 4 to 6, and Annex 3). The relationship between education and obesity in different ethnic groups was similarly explored through an interaction term between years of education and ethnicity (minority status in Canada, migrant status in Australia). The relationship between BMI and education was analysed using ordinary least squares regression models including the same covariates listed above (Figure 3 and Annex 2). All analyses were conducted using Stata 10.

Obesity rates, as well as BMI levels, by years of education were reported in separate graphs for different population groups. The linearity of the relationship between education and obesity and BMI was assessed visually, based on those graphs.

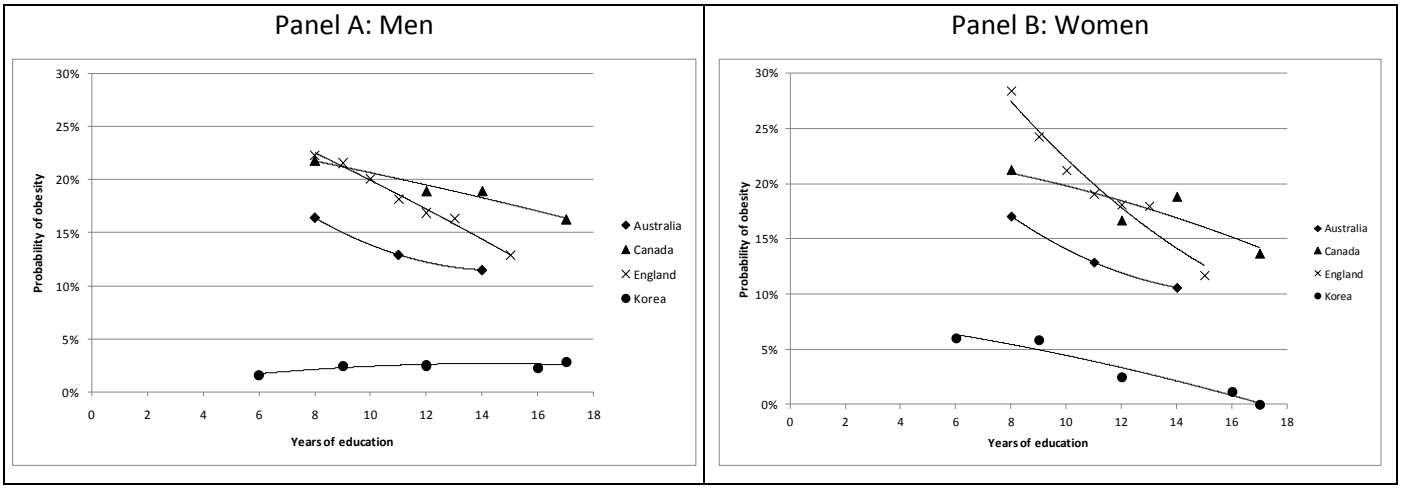
The effects of the clustering of individuals into households or geographical areas were studied using multilevel statistical models, also known as hierarchical linear models, random effects models or nested models (see Annex 4). Multilevel analyses concerned England and Korea data which are based on household structure. Two-level random-intercept models, using households as higher-level units of

aggregation, were tested on samples of people aged 25-64, living in household comprising at least two members. It was not possible to perform this analysis on Australian and Canadian data, since the relevant surveys do not have a household structure.

Is the strength of the correlation between education and obesity constant across the entire education spectrum, overall and in different population sub-groups?

Figure 2 shows the relationship between education and obesity for each gender in the four countries. Obesity rates in Figure 2 and BMI levels in Figure 3 are regression estimates adjusted for age, gender, and socio-economic status. Full results are presented in Annex 2. The relationship is negatively sloped in all cases except in Korean man, indicating that each additional year of education is consistently associated with a lower chance of being obese in Australia, Canada and England, as well as in Korean women. For Korean men, no conclusive results could be obtained as none of the coefficients for education were significant in the regression analysis, possibly due to the relatively small number of individuals who are obese in the country.

Figure 2. Relationship between obesity and years of education



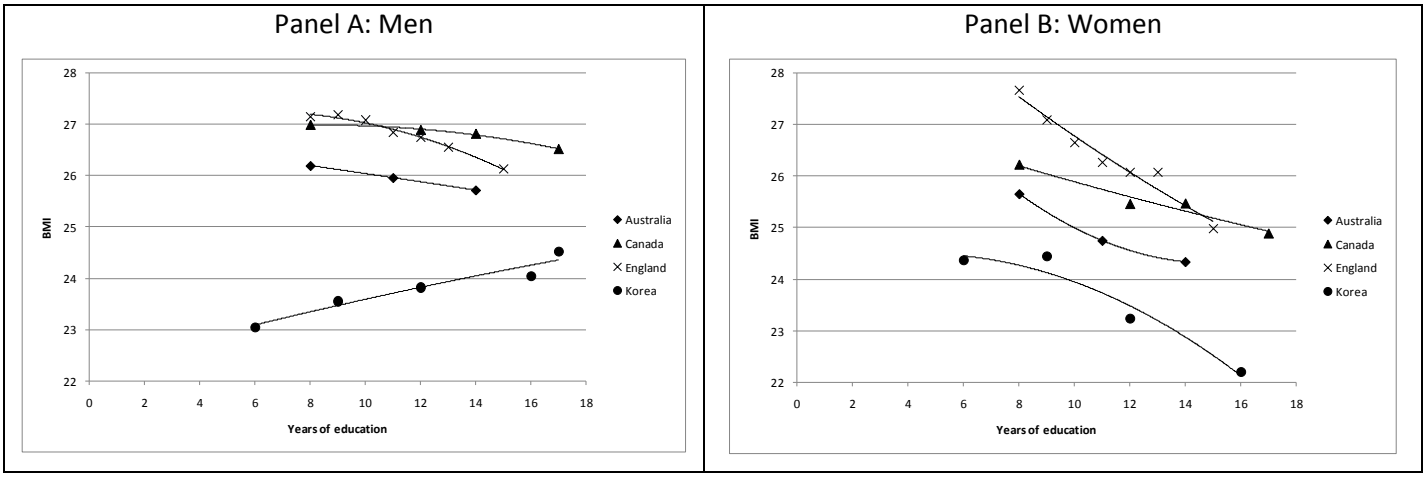
Source: Authors' estimates from logistic regression, see Annex 2.

The patterns shown in Figure 2 suggest that the relationship between obesity and years of education may be considered broadly linear, *i.e.* of a constant strength across the entire education

spectrum. However, results for England and Canada might suggest that the effect of further years of education tends to decrease progressively when approaching completion of upper secondary education (13-14 years of schooling), and then increase again sharply in individuals who complete tertiary education. A similar effect was also found for men in Australia, based on 2001 and 2005 data, which provided more detailed information on years of education relative to other editions of the same survey.

When the relationship between average BMI and education is observed, as in Figure 3, the conclusions are similar to what was previously discussed. No clear and consistent deviation is observed from a linear pattern in the four countries examined. Again Korean men represent an exception, as they display a positively sloped relationship, which seems substantially more marked than in Figure 2, where the link between education and obesity was examined.

Figure 3. Relationship between BMI and years of education

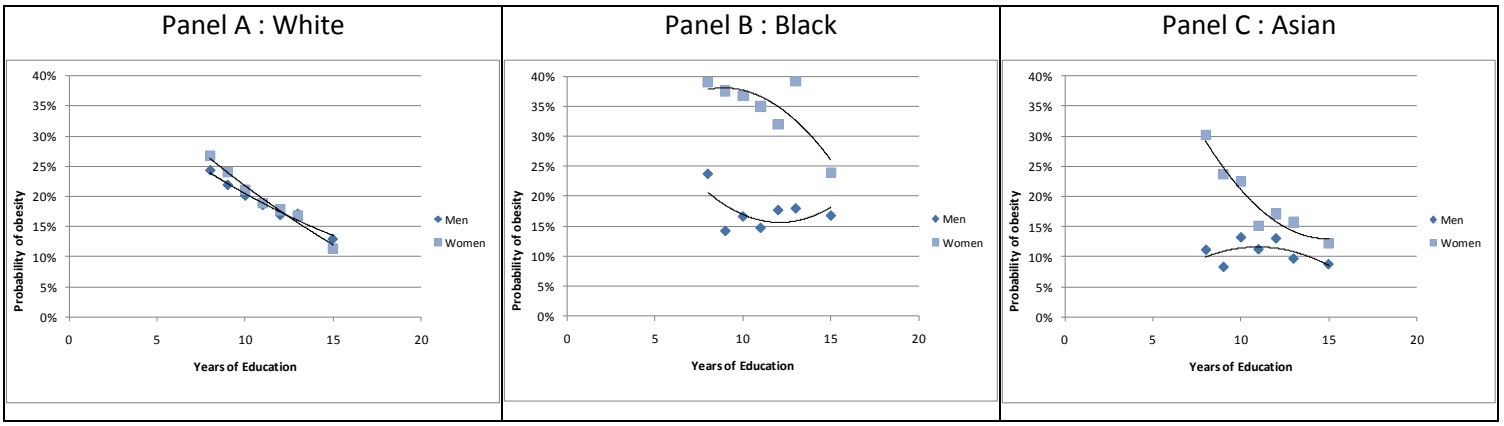


Source: Authors' estimates from linear regression, see Annex 2.

The relationship between obesity and education was observed in different sub-groups along dimensions reflecting ethnicity or minority status (Figures 4 to 6). Obesity rates presented in Figures 4 to 6 are estimates adjusted for age, gender, and SES. Full results are presented in Annex 3. Three ethnic groups were identified in England (White, Black, Asian), while binary variables were used in Canada and Australia to denote, respectively, ethnic minority status and migrant status. The slope of the correlation between education and obesity is broadly similar in women, across all ethnic groups, although Black women display significantly higher obesity rates than others. It is difficult to assess whether the different patterns observed in Black and Asian women, suggesting a concave relationship between education and obesity in the former and a convex relationship in the latter, reflects a true difference in the impact of

education in the two groups. However, this interpretation of concavity and convexity on few data points should be taken with caution, as it is sensitive to outliers. This finding demands a larger and more detailed investigation. Education appears to be much more weakly correlated with obesity in Black and Asian men, although the least educated among Black men are substantially more likely to be obese than their more educated counterparts.

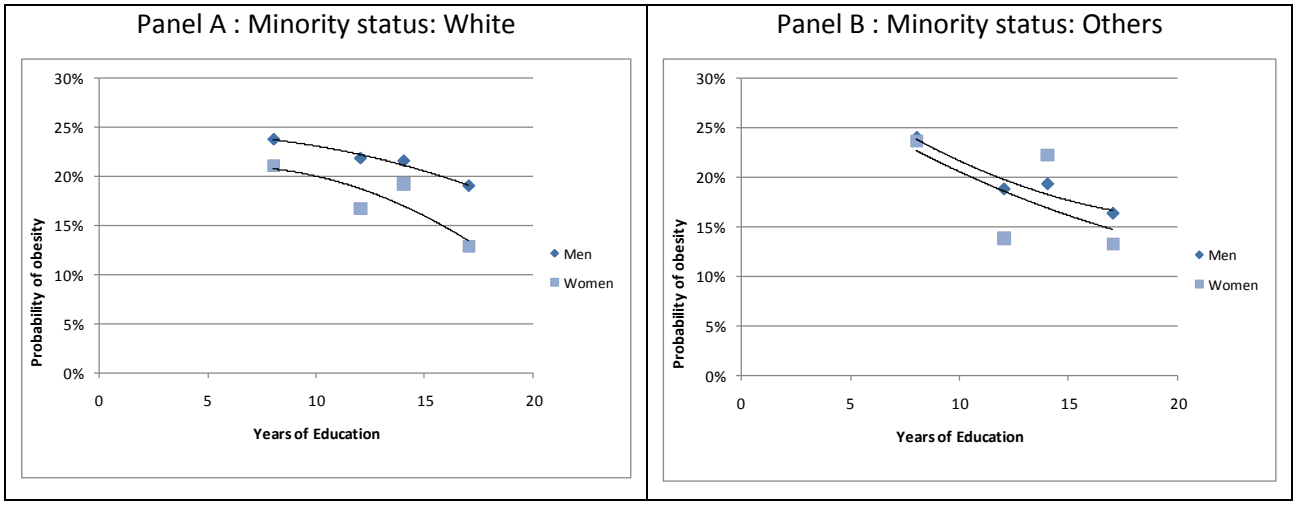
Figure 4. Relationship between obesity and years of education by ethnicity groups in England



Source: Authors' estimates from logistic regression, see Annex 3.

In Canada, individuals who belong to ethnic minority groups are less likely to be obese than White majority individuals. The relationship between obesity and education level is negatively sloped in both men and women, regardless of minority status, as illustrated in Figure 5.

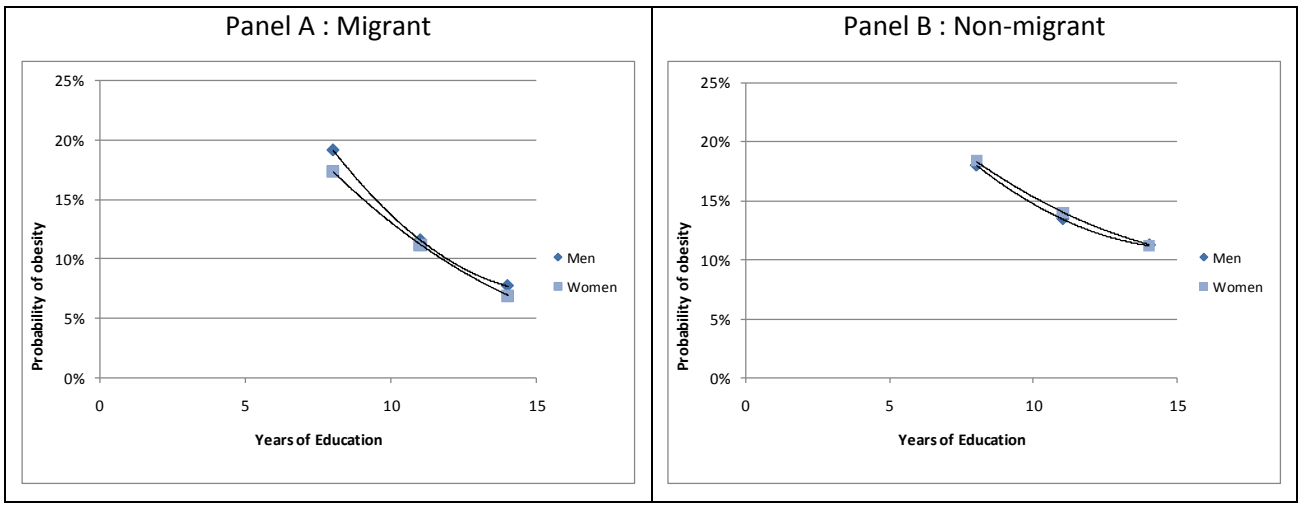
Figure 5. Relationship between obesity and years of education by minority status in Canada



Source: Authors' estimates from logistic regression, see Annex 3.

The analysis of the correlation between obesity and education in Australia does not show significant differences by migrant status, as illustrated in Figure 6.

Figure 6. Relationship between obesity and years of education by migrant groups in Australia



Source: Authors' estimates from logistic regression, see Annex 3.

In addition, regression analyses presented in Annex 2 and 3 were adjusted for SES. Obesity tends to be more prevalent in disadvantaged socio-economic groups, and inequalities are consistently larger in women than in men. A more detailed analysis of social inequalities in obesity is presented in a separate study (Devaux and Sassi, 2011).

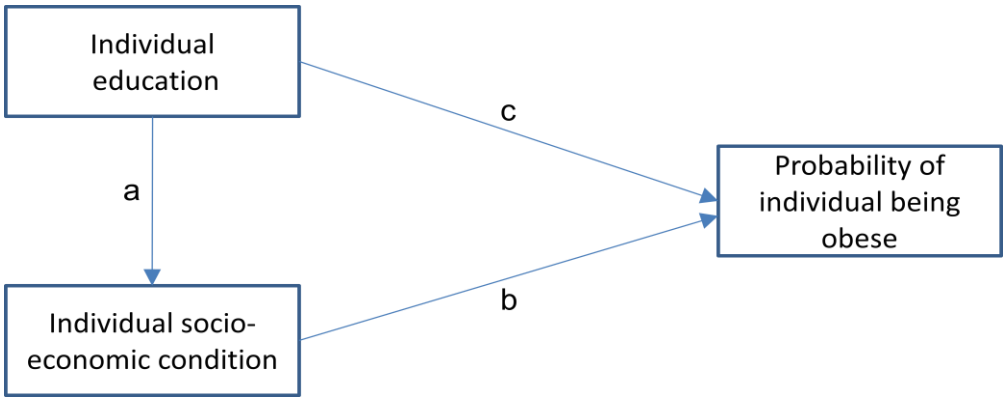
Does the relationship between education and obesity reflect the role of other factors associated with individual education?

Several factors associated with individual education may potentially have an influence on the correlation observed between education and BMI/obesity. In particular, we studied the influence of individual socio-economic status and of the education level of household members.

In addition to its direct effect on the likelihood of obesity, individual education may also have an indirect effect, mediated by individual socio-economic status. Figure 7 describes the hypothesised ***mediation effect***. Individual education contributes to determining individual socio-economic status (*a*), which in turn has an influence on the likelihood of obesity (*b*). Such mediated effect adds to the direct

effect of education on obesity[13] (*c*). In order to test for the existence of the hypothesised mediation effect, a series of logistic regression models were developed with and without controlling for the socio-economic status covariate, to assess possible variations in the coefficients of the individual education variable. Results are consistent with a slight mediation role played by socio-economic status in the relationship between education and obesity since odds ratios of obesity according to education level change slightly towards a unitary value, when the role of socio-economic status is accounted for (Sassi *et al.*, 2009). However, it should be noted that this empirical strategy does not account for a potential reverse causality in the relationships outlined in Figure 7 (*a*, *b* and *c*).

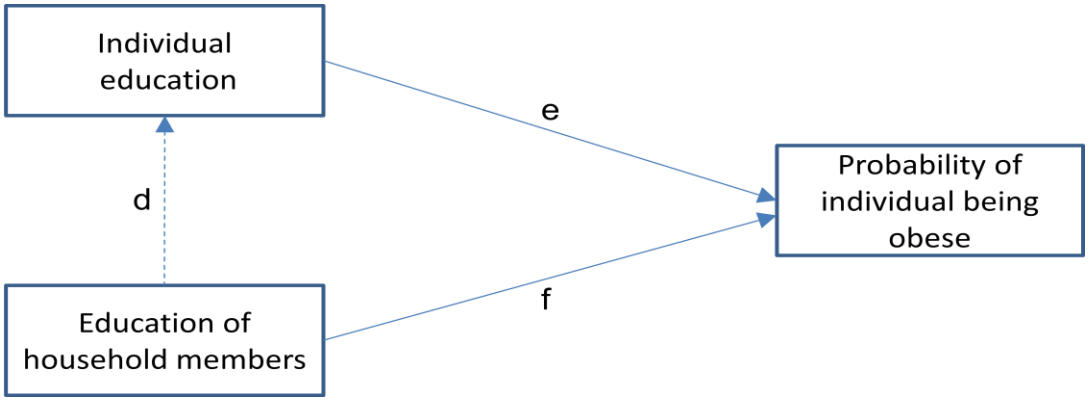
Figure 7. Indirect effect of individual education through individual socio-economic status



A further analysis focused on the education of household members, which might have a direct influence on the likelihood of an individual being obese, *i.e.* it may have a ***concurrent effect*** to that of individual education (relationships *e* and *f* in Figure 8). In principle, individual education may also act as a mediator of the household education effect on obesity (*d* and *e* in Figure 8). However, the analysis focused on the former (concurrent) effect of the education of household members.

[13] The assumption on the direction of the causal link from the former to the latter is further discussed later in the paper.

Figure 8. Indirect effect of education of household members



The concurrent effect of household education could bias estimates of the effect of individual education on obesity. The education of household members could be, indeed, viewed as an omitted variable that would bias the model's coefficients. So, to test for this concurrent effect, regression models with and without this covariable were computed. This analysis is limited to England and Korea, the two countries for which household-based surveys are available. Multilevel logistic models were used to account for household structure (see Annex 4 for details of methods used). The education of household members is defined as the years of education of the spouse of the head of household and, when the latter was not available, as the years of education of the head of household.[14]

Odds ratios for the probability of being obese in England are displayed in Table 1. Model 1 is a multilevel logistic model without controls for the level of education of household member, whereas model 2 accounts for the education of household members. Differences among households explain about one fifth of the total variance in the likelihood of obesity (see the intra-class correlation coefficient Rho, in Table 1). It is worth noting that household education is negatively correlated to obesity status (odds ratio < 1) with significant values when years of education are above 11. Comparison of model 2 with model 1 shows that there seems to be a small concurrent effect of household education on obesity, which adds to the effect of individual education, since odds ratios of obesity according to individual education become smaller and closer to 1.

[14] We tested whether this distinction in the construction of the variable had an effect on obesity status by introducing a control dummy variable, but it was not significant.

Table 1. Odds ratios and significance for the probability of obesity in England

England	Model 1: without controls		Model 2: with controls for household education	
	Odds Ratios	*Significance*	Odds Ratios	*Significance*
Age	1.070	***	1.073	***
Age squared	0.999	***	0.999	***
Year of survey	1.065	***	1.067	***
Women	1.441	***	1.381	***
Years of education - Men				
8	ref.		ref.	
9	0.937		0.967	
10	0.860	**	0.916	
11	0.767	***	0.859	*
12	0.703	***	0.798	**
13	0.671	***	0.796	***
15	0.522	***	0.636	***
Years of education - Women				
8	ref.		ref.	
9	0.746	***	0.784	***
10	0.630	***	0.697	***
11	0.552	***	0.664	***
12	0.514	***	0.615	***
13	0.505	***	0.648	***
15	0.304	***	0.390	***
Ethnicity				
White	ref.		ref.	
Black	1.714	***	1.729	***
Asian	0.738	***	0.734	***
SES				
highest	ref.		ref.	
middle-high	1.252	***	1.253	***
middle	1.199	***	1.192	***
middle-low	1.347	***	1.337	***
lowest	1.481	***	1.466	***
Years of education of household				
8			ref.	
9			0.951	
10			0.893	
11			0.812	**
12			0.819	**
13			0.752	***
15			0.749	***
Observations	102051		100202	
Log-likelihood	-49860.1		-48867.7	
Rho	0.195	***	0.196	***

Note: (***) means significant at 1%, (**) at 5%, (*) at 10%.

Source: Cross-sectional survey data from Health Survey for England 1991-2005; Authors' calculations.

Table 2 shows the results of the corresponding analysis for Korea. In this case, differences among households explain about 7% of the total variance in the likelihood of obesity (see intra-class correlation in Table 2). In both models, odds ratios for men are not significantly different from 1, although the

strength of the correlation between obesity and individual education is somewhat diminished in model 2, similarly to what was observed in England. On the other hand, the correlation between individual education and obesity appears marginally strengthened when accounting for household education in women, contrary to expectations. However, the absence of a statistically significant correlation between household education and obesity prevents from drawing any conclusions on the role of the latter in Korea.

Table 2. Odds ratios and significance for the probability of obesity in Korea

Korea	Model 1: without controls		Model 2: with controls for household education	
	Odds Ratios	*Significance*	Odds Ratios	*Significance*
Age	0.961		0.965	
Age squared	1.000		1.000	
Year of survey	1.070	***	1.071	***
Women	3.871	***	3.759	***
Years of education - Men				
6	ref.		ref.	
9	1.551		1.385	
12	1.582		1.439	
16	1.438		1.123	
17	1.810		1.209	
Years of education - Women				
6	ref.		ref.	
9	0.959		0.795	
12	0.408	***	0.394	***
16	0.189	***	0.152	***
Years of education of household				
6			ref.	
9			1.181	
12			1.053	
16			1.320	
17			2.281	
SES				
highest	ref.		ref.	
middle-high	0.971		0.940	
middle	1.006		0.991	
middle-low	1.040		1.059	
lowest	1.203		1.215	
Observations	15441		15199	
Log-likelihood	-2039.7		-1998.8	
Rho	0.077		0.073	

Note: (***) means significant at 1%, (**) at 5%, (*) at 10%.

Source: Cross-sectional survey data from KNHANES 1998-2005; Authors' calculations.

Do the data provide evidence of the causal nature of the link between education and obesity?

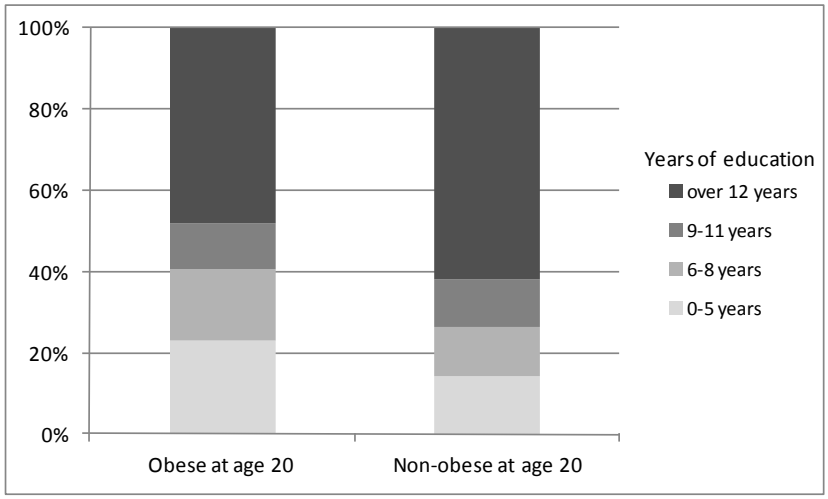
When exploring the cross-sectional relationship between obesity and education, it is difficult to interpret the direction of the causal link between the two variables. In addition, the correlations identified might be affected by the omission of relevant variables in the analysis.

The existence of a reverse causal effect (obesity in young age determines the level of educational achievement of an individual) is supported by the findings of several studies. Sargent and Blanchflower (1994), using panel data, showed an inverse relationship between obesity at age 16 and earnings at 23 in young women. Gortmaker *et al*. (1993) found that women who were overweight in childhood completed fewer years of school. Crosnoe and Muller (2004) found that students at risk of obesity achieved worse outcomes in schools characterized by higher romantic activity, lower mean BMI or lower rate of athletic participation, than they did in schools lower in romantic activity, higher in mean BMI or higher in athletic participation.

Since no suitable instrument for education was identified in the available survey data, nor could be linked from external sources, it was not possible to address endogeneity issues satisfactorily in the analysis. However, an attempt to explore the direction of the causal link between education and obesity was made possible by data from an additional country, France[15]. The data from *Enquête Décennale Santé 2002-2003* provides information on body weight at age 20, which was taken to reflect obesity status at school age. The data shows that being "obese at age 20" is positively and significantly correlated with obesity in adulthood (correlation 0.177) and is negatively and significantly correlated with the number of years spent in education (correlation -0.035). Figure 9 shows that those who were obese at age 20 have significantly lower levels of educational attainment than those who were not obese, suggesting a potential for reverse causality in the relationship between education and obesity.

[15] A second test for the causal nature of the link between education and obesity was carried out using data from the Health Survey for England in a sort of natural experiment, assessing the impact of the educational reform introduced in England in 1973, which increased the minimum compulsory schooling age from 15 to 16 years. Clark and Royer (2008) used this approach with reference to an earlier educational reform implemented in England in 1947, which also increased the minimum compulsory schooling age in the country, from 14 to 15. They found that cohorts affected by the law display only slightly improved long-run health outcomes and their findings did not support a causal link between education and obesity. Our results consistently indicated an absence of change in the likelihood of obesity in the cohorts affected by the educational reform, relative to previous cohorts. This finding does not necessarily indicate that the link between education and obesity is not of a causal nature. Rather, it may suggest that school reforms leading to small changes in minimum compulsory schooling age do not provide sufficiently strong means for implementing an instrumental variables approach.

Figure 9. Distribution of years of education according to obesity status at age 20



Source: French data from Enquête Décennale Santé 2002-03; Authors' calculations.

In order to assess the influence of such potential reverse causal effect on the observed correlation between education and adult obesity, the results of two regression analyses assessing factors associated with adult obesity were compared, in one of which the "obesity at age 20" variable was included as an additional covariate (Table 3). Comparing Model 1 (without control) and Model 2 (with control) is a way of assessing whether the strength of the association between education and obesity is affected by a potential reverse causality. Odds ratios of obesity relative to education for women are virtually identical in both models, while small changes are observed in odds ratios for men. This comparison suggests that a reverse causal effect is unlikely to have a significant influence on the strength of the correlation observed between education and adult obesity. However, there remains an issue of potential recall bias concerning body weight at age 20, as suggested by the fact that individuals tended to report round numbers (*e.g.* 60, or 65 kg).

Table 3. Odds ratios for obesity in adulthood in France (age range 25-64)

France	Model 1: without control for obesity at age 20		Model 2: with control for obesity at age 20	
	Odds Ratios	*Significance*	Odds Ratios	*Significance*
Age	1.13	***	1.14	***
Age squared	1.00	***	1.00	***
Women	1.26	**	1.31	**
Years of education - Men				
0-5 years	ref.		ref.	
6-8 years	0.93		0.98	
9-11 years	0.75	**	0.79	
over 12 years	0.85	*	0.90	
Years of education - Women				
0-5 years	ref.		ref.	
6-8 years	0.84	*	0.83	*
9-11 years	0.54	***	0.54	***
over 12 years	0.52	***	0.53	***
Obese at age 20			15.53	***
Occupation (SES)				
Blue collar workers	ref.		ref.	
Craftmen	0.82	**	0.81	**
Farmers	0.88		0.84	
Clerks	0.82	***	0.82	***
Intermediate professions	0.65	***	0.66	***
Managers, Professionals	0.42	***	0.43	***
Working status				
Working	ref.		ref.	
Not working	1.29	***	1.29	***

Note: (***) means significant at 1%, (**) at 5%, (*) at 10%.

Source: French data from Enquête Décennale Santé 2002-03; Authors' calculations.

What theoretical model of the influence of education on social outcomes is supported by the data?

As a final step in our empirical analysis, we assessed which of the absolute, relative and cumulative conceptual models of the outcomes of education proposed by Campbell (2006) is empirically supported by the data.

BOX 3: The absolute, relative and cumulative models

The relationship between education and obesity may be interpreted according to various models/hypotheses, which involve alternative mechanisms. Three such models were conceptualised by Campbell (2006) as follows.

The **absolute model** implies that the probability that individuals will be obese depends on their level of education. According to this model, education may reduce the probability that an individual will be obese both by increasing the stock of information available to the individual concerning the health risks associated with unhealthy lifestyles, and by improving their ability to understand and handle such information. When the effects of education are in line with the predictions of the absolute model, policies which successfully promote education and learning and increase the average educational attainment of a population will have the effect of decreasing obesity rates. While our hypothesis is that the absolute model of education generally leads to lower rates of obesity through increased education, the absolute effect of education might also be negative. If education increases wages, and therefore increases the opportunity cost of leisure time, an educated individual's propensity to engage in leisure time physical activity or home meal preparation will likely be reduced.

The **relative model** implies that education serves as a marker of social status and an individuals' level of education relative to their peers', or relative to the prevailing level of education in the relevant social environment, is what affects the probability that they will be obese. This model implies that a generalised increase in the level of education of an entire community may not alter individual outcomes, unless the relative position of individuals within that community changes as a result.

The **cumulative model** rests on the idea that the impact of individual education on obesity is consistent with, and additive to, the impact of the level of education of other members of the same community. Therefore, the likelihood that an individual may become obese depends both on the individual's own level of education and on the level of education of other community members.

To test the above models, logistic regression analyses of the likelihood of obesity were run on the four countries' data using a similar approach to that proposed by Campbell (2006) in his analysis of civic and social engagement as an outcome of education. Regression models included, in addition to the control variables gender and age, two measures of education: the number of years of education completed by the individual respondent (education level) and the mean level of education completed by members of the same age cohort within the same country (educational environment). In order to calculate the educational environment variable, four 10-year birth cohort groups were devised: 1941-50, 1951-60, 1961-70, 1971-80. Mean education levels within each cohort were standardised using the 2005 national distributions of levels of education (lower secondary; upper secondary; tertiary education) by age group, available in *Education at a Glance 2007* (OECD, 2007). Findings of a statistically significant and strong

negative effect of individual level education on obesity would provide support for the absolute model. A positive correlation between educational environment and obesity could be interpreted as evidence of a relative effect of education, especially if the correlation is stronger than that between individual education and obesity. Findings indicating that individual education is negatively correlated with obesity and the educational environment variable is negatively correlated with obesity would lend support to the cumulative model, especially if the latter correlation were stronger than the former (Campbell, 2006).

Table 4 indicates that better educated individuals are less likely to be obese than their less educated counterparts in all of the countries considered. This result can be viewed as evidence in support of the absolute effect of education model, mirroring evidence in the literature on the importance of individual level education for health status and health behaviours. However, after accounting for individual level education, those who are exposed to better educated environments in Australia, Canada and England are significantly more likely to be obese. This finding supports the relative model of the effects of education, which appears to play a larger role than the absolute model in explaining the distribution of obesity across social groups. Educational environment estimate is not significant in Korea which gives evidence for the absolute model.

Table 4. Odds ratios and significance for likelihood of obesity when controlling for cohort education level

	Australia	**Canada**	**England**	**Korea**
Age	1.060 ***	1.026 ***	1.157 ***	0.992
Age squared			0.999 ***	1.000
Women	0.859 ***	0.808 ***	1.138 ***	1.179
Individual education	0.912 ***	0.959 ***	0.913 ***	0.921 ***
Educational environment	3.347 ***	1.184 ***	2.015 ***	0.989
SES				
highest	ref.	ref.	ref.	ref.
middle-high	1.179 ***	1.099 ***	1.232 ***	0.946
middle	1.158 ***	1.104 ***	1.221 ***	0.912
middle-low	1.531 ***	1.106 **	1.397 ***	1.057
lowest	1.365 ***	1.189 ***	1.488 ***	1.200
Ethnicity				
White			ref.	
Black			1.675 ***	
Asian			0.780 ***	

Note: In Australia and Canada age squared is not available as the age variable is categorical; we use mid-age of each category. (***) means significant at 1%, (**) at 5%, (*) at 10%.

Source: Authors' calculations based on national survey data.

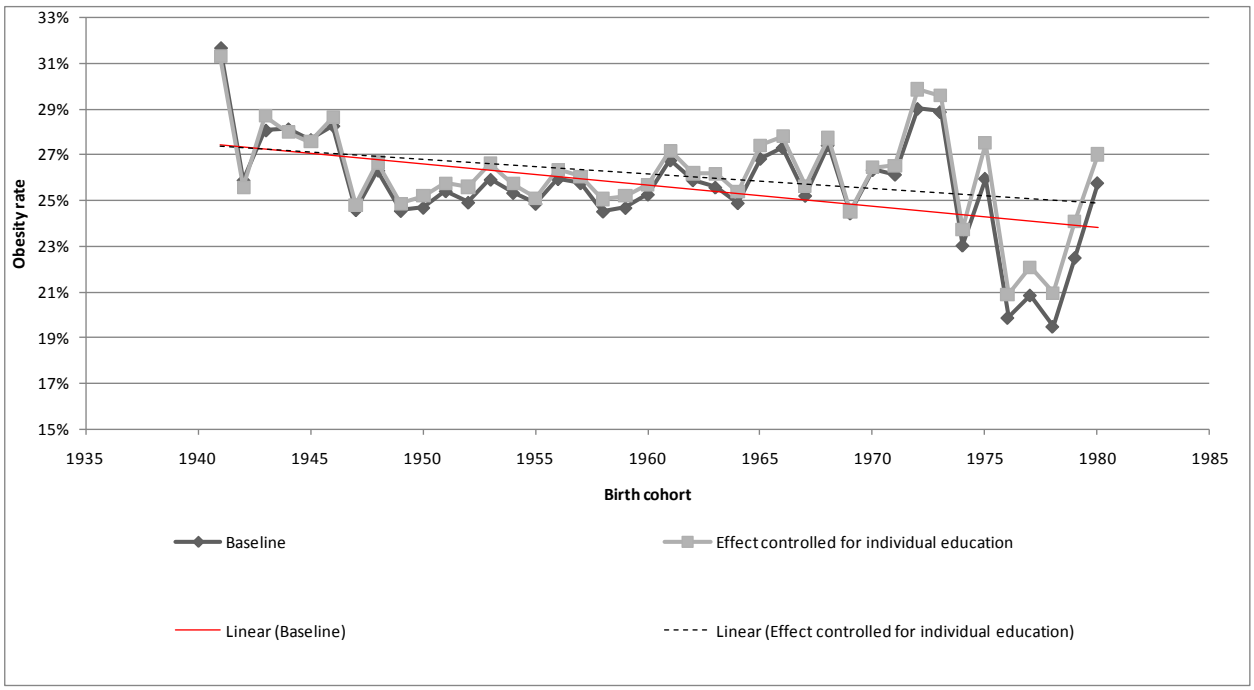
The relative effect could operate through several pathways. One pathway that is consistent with both the absolute and the relative models is that linking social position to stress levels and eventually to health outcomes. Evidence has been gathered that individuals who have a lower social position are exposed to higher levels of perceived stress, because of a lower degree of control over their jobs and their life circumstances and because of a less satisfactory balance between efforts and rewards (Siegrist and Marmot, 2004). This is associated with a reduced ability to handle environmental pressures and often translates into less healthy lifestyles, obesity, chronic diseases and premature mortality (Brunner *et al*, 2007; Chandola *et al*., 2008). A second pathway which typically reflects features of the relative model of the effects of education is linked to a higher demand for health inputs that are associated with a healthy weight, e.g. gym and health club memberships, by those who have higher levels of education and occupy higher social positions. In communities where the average level of education is higher, demand for such inputs, and consequently the price of those inputs, are also likely to be higher, hindering access to the same resources for the less educated and less well-off.

A further analysis was carried out to test for a possible effect of individual education on obesity, consistent with the *absolute* model discussed above. The analysis exploited age-period-cohort models of obesity developed by Sassi *et al* (2009) with the aim of disentangling the effects of the three time-related factors (individual age, period of observation and birth cohort) on the likelihood of obesity. The findings of the main analysis showed negatively sloped cohort effects, suggesting that individuals born in more recent cohorts, other things being equal (including age), have a lower probability of being obese than individuals born in earlier cohorts, with a possible flattening of the cohort effect curve for the most recent cohorts. Here, these models were completed by adding a control for individual education, for the purpose of testing whether improvements in education over time may account for at least part of the negatively sloped cohort effects observed in the main analysis, *i.e.* whether a higher level of education may partly explain why individuals born in more recent cohorts have a lower probability of being obese. The age-period-cohort model used in the analyses is the one proposed by Yang, Fu and Land (2004), based on a robust estimator (intrinsic estimator) which does not require the identification of constraints on the parameter vector by using prior information. The intrinsic estimator method (Fu, 2000; Knight and Fu, 2000; Fu and Hall, 2004; Fu and Rohan, 2004) considers an orthogonal decomposition of the parameter space into a null space for the singular design matrix and a non-null space, where the intrinsic estimator is obtained by the Moore-Penrose generalized inverse. Analyses were carried out on data from

Canada and England. Obesity rates in Korea are too low for this analysis to produce meaningful results, and Australian data were not directly accessible at the individual level.

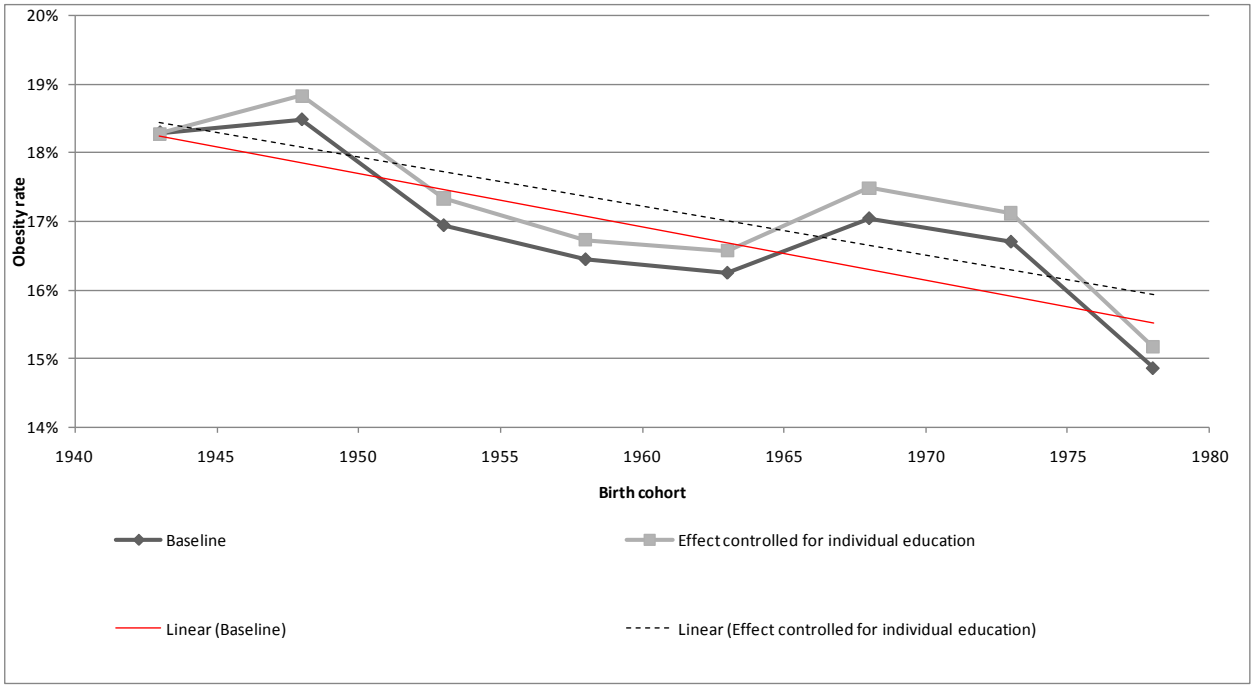
An age-period-cohort analysis allowed to disentangle the impact of the three time-related effects on obesity. The findings of such analysis (reported in Sassi *et al.*, 2009) show declining cohort effects in Canada, England and, to a lesser degree, in Korea (no APC analysis could be undertaken on Australian data). After inclusion of individual education as a covariate in the regression models for the two countries with more pronounced cohort effects, trends in cohort effects become more flat (Figures 10 and 11). This means that part of the reduction in the likelihood of obesity in younger birth cohorts is explained by their higher degrees of educational attainment achieved by individuals in the same cohorts, which is consistent with the absolute model of the effects of education on obesity.

Figure 10. Negative cohort effect with/without controls for education level in England



Source: Authors 'calculation based on national survey data

Figure 11. Negative cohort effect with/without controls for education level in Canada



Source: Authors 'calculation based on national survey data

Conclusions

A range of analyses of health survey data from Australia, Canada, England and Korea were undertaken with the aim of exploring the relationship between education and obesity. The findings of these analyses show a broadly linear relationship between the number of years spent in full-time education and the probability of obesity, with most educated individuals displaying lower rates of the condition (the only exception being men in Korea). This suggests that the strength of the correlation between education and obesity is approximately constant throughout the education spectrum. Increasing education at any point along that spectrum would be expected to reduce obesity to a similar degree, if the causal nature of the link between education and obesity had been established.

The education gradient in obesity is stronger in women than in men. Differences between genders are minor in Australia and Canada, more pronounced in England and major in Korea. The gradient has not meaningfully changed over the time periods covered by the health survey data available for our study. However, there is at least some evidence that over longer periods of time more educated individuals

have been less likely to be become obese than their less educated counterparts, suggesting that education produces its influence on obesity only in the long term.

The causal nature of the link between education and obesity has not yet been proven with certainty. Our own attempt to use a natural experiment, involving a school reform which increased the minimum compulsory schooling age in England by one year in 1973, failed to establish a causal link. However, using data from France we were able to ascertain that the direction of causality appears to run mostly from education to obesity, as the strength of the association is only minimally affected when accounting for reduced educational opportunities for those who are obese in young age. Most of the effect of education on obesity is direct. Small components of the overall effect of education on obesity are mediated by an improved socio-economic status linked to higher levels of education, and by a higher level of education of other family members, associated with an individual's own level of education.

The positive effect of education on obesity is likely to be determined by at least three factors: (a) greater access to health-related information and improved ability to handle such information; (b) clearer perception of the risks associated with lifestyle choices; and, (c) improved self-control and consistency of preferences over time. However, it is not just the absolute level of education achieved by an individual that matters, but also how such level of education compares with that of the individual's peers. The higher the individual's education relative to his or her peers', the lower is the probability of the individual being obese. The latter effect may be due to different levels of perceived stress experienced by individuals in different social positions, and by different coping mechanisms. Access to resources required to maintain a healthy weight may also be driven by an individual's position in the social hierarchy.

The findings reported in this paper concerning the relationship between education and obesity are consistent with those reported in a number of other studies, notably Spasojevic (2003), Arendt (2005), Kenkel *et al*. (2006), Cutler and Lleras-Muney (2006), Sánchez-Vaznaugh *et al*. (2009). Several of the above studies showed a strong education gradient in BMI or obesity, with the better educated, especially if women, less likely to be overweight or obese. We found similar evidence in all of the four countries examined, with the largest differences between genders in Korea, the only country in which an inverse gradient (more education associated with higher obesity rates) was observed in men. This used to be a common pattern in many countries early in the 20th century, and it is possible that some countries which still display relatively low obesity rates, like Korea, still retain that feature as a sign of the slower transition they have been experiencing in the weight distribution across population groups. Cutler and

Lleras-Muney (2006) also found that the gradient in obesity was steeper in whites than in ethnic minorities. In our study, a detailed analysis by ethnic group could be undertaken using data from England, which showed substantially milder education gradients in obesity for minority men, relative to white men, but similar gradients in women of different ethnic backgrounds.

It should be noted that BMI was measured in England and Korea, but self-reported in Canada and Australia. The use of self-reported data may potentially cause bias in the results, as a number of people tend to report incorrectly their height and weight. However, there is no clear evidence that self-report bias may vary among individuals with different levels of education. Therefore, the correlations reported in this paper may not be affected in a major way by this potential limitation. Also, BMI is not an accurate measure of body fat, or body composition. For instance, those with a substantial muscular mass because of intense physical activity may have a high BMI but a low risk for chronic diseases. However, BMI is a widely reported measure which has proven to be particularly useful in population-level analyses. There is evidence that the link between BMI and the associated health risks is different in Asian populations, suggesting that lower BMI thresholds should be used in the latter to identify individuals who are overweight or obese. In the present study we applied the same thresholds in all countries.

The analyses presented in this paper were based on cross-sectional health survey data, which provide a very detailed source of information on the health and health-related behaviours of the respective populations, but at the same time present a number of limitations, especially in the assessment of the causal nature of the link between education and obesity. Individual education was defined as the number of years spent in full-time education, although this was available in a discrete form and interpolations were required. No information was available on the quality and contents of the education received, which are also likely to influence health and health-related behaviours in adult life.

Policy Implications

Establishing the causal nature of links between obesity and policy levers that could potentially be used to curb the current epidemic is essential for effective policies to be designed and implemented. If changes in education could be expected to influence health-related behaviours and obesity rates in a population, this might strengthen the case for educational policies aimed, for instance, at increasing compulsory schooling age or increasing enrolment in higher education. Our analysis in Table 4 provides

an estimate of the size of such effect. Increasing education by one year in the whole population would decrease the overall obesity rate by 4% in Canada, and up to 9% in England. Cutler and Lleras-Muney (2006), with reference to the broader health effects of education, argued that if a causal link were proven, education subsidies might be desirable. These would promote higher levels of education for a larger share of the population and correspondingly improve population health. Grossman and Kaestner (1997) argued that education policies directed at disadvantaged groups might reduce some of the existing health disparities. Although the evidence currently available, including some of the findings of our study, provides strong suggestions that at least part of the correlation between education and obesity is of a causal nature, a conclusive proof of this does not yet exist.

Health education programs aimed at promoting healthy lifestyles might in principle generate similar effects to those associated with school education by providing relevant information. However, Speakman *et al*. (2005) argue that these campaigns are likely to be ineffective "if people in lower social strata already know what foods have high energy contents, but fail to act on this information", suggesting that health promotion would mostly help those who have a higher level of education. However, very limited empirical evidence exists concerning the effects of health education programmes, and virtually none is available on differences in effectiveness between socioeconomic groups. Haas (2008) suggested that more funding should not be spent on public health education campaigns while clear evidence of the effectiveness of such programs does not exist.

Whether through formal schooling or health promotion campaigns, education may play a role in tackling overweight and obesity. Policy makers need to consider what levels of evidence should be deemed sufficient to prompt action, and how efficiency and equity objectives should be balanced in tackling obesity. Education policies aimed at increasing formal schooling include a flexible range of policies, which may be targeted at specific age and socioeconomic groups. We showed that the strength of the link between education and obesity is approximately constant throughout the education spectrum, which means that similar gains could be achieved in terms of reduction of obesity rates by increasing educational attainment for early school leavers as well as for those who spend the longest in full time education. However, policies targeting early school leavers would likely improve equity by focusing on individuals who are more likely to belong to disadvantaged socioeconomic groups. Similar results could be achieved by improving access to education, *e.g.* through financial incentives, for disadvantaged groups.

REFERENCES

Aitkin, M., D. Anderson and J. Hinde, (1981), "Statistical Modelling of Data on Teaching Styles (with Discussion)", *Journal of Royal Statistic Society,* A 144, pp. 148-61.

Aitkin M. and N.T. Longford (1986), "Statistical Modelling Issues in School Effectiveness Studies (with Discussion)", *Journal of Royal Statistic Society,* A 149, pp. 1-43.

Arendt, J. N. (2004), "Does Education Cause Better Health? A Panel Data Analysis Using School Reforms for Identification", *Economics of Education Review,* vol. 24, no. 2, pp. 149–60.

Appiah, E. and McMahon, W.W. (2002). "The social outcomes of education and feedbacks on growth in Africa," *Journal of Development Studies*, 38(4): 27–68.

Branca, F., H. Nikogosian and T. Lobstein (eds.) (2007), "The Challenge of Obesity in the WHO European Region and the Strategies for Response", WHO Regional Office for Europe, Copenhagen.

Brunello G. and B. d'Hombres, (2006), "Does Body Weight affect Wages? Evidence from Europe," "Marco Fanno" Working Papers 0027, Dipartimento di Scienze Economiche "Marco Fanno".

Brunello G., D. Fabbri and M. Fort (2009), Years of Schooling, Human Capital and the Body Mass Index of European Females. IZA Discussion Paper No. 4667. Available at http://ftp.iza.org/dp4667.pdf the 11 Feb. 2010.

Brunner E.J., T. Chandola and M. Marmot (2007), "Prospective Effect of Job Strain on General and Central Obesity in the Whitehall II Study", *American Journal of Epidemiology*, vol. 165(7), pp. 828-37.

Campbell, D. E. (2006), "What is Education's Impact on Civic and Social Engagement ? ", R. Desjardins and T. Schuller (eds.), *Measuring the Effects of Education on Health and Civic/social Engagement*, OECD/CERI, Paris, pp. 25–126.

Card, D. (2001). "Estimating the return to schooling: progress on some persistent econometric problems," *Econometrica,* 69(5): 1127-1160.

Cawley, J. (2004), "The Impact of Obesity on Wages", *Journal of Human Resources*, vol. 39(2), pp. 451-474.

Chandola T., A. Britton, E. Brunner, H. Hemingway, M. Malik, M. Kumari, E. Badrick, M. Kivimaki and M. Marmot (2008), "Work Stress and Coronary Heart Disease: What are the Mechanisms?", *European Heart Journal*, vol. 29(5), pp. 640-8.

Clark, D. and H. Royer (2008), "The Effect of Education on Adult Mortality and Health: Evidence from the United Kingdom", www.frbsf.org/economics/conferences/0806/royer.pdf, accessed on 8 April 2009

Crosnoe, R. and C. Muller (2004), "Body Mass Index, Academic Achievement, and School Context: Examining the Educational Experiences of Adolescents at Risk of Obesity", *Journal of Health and Social Behavior*, Vol. 45 (December), pp. 393–407.

Cutler, D. and A. Lleras-Muney (2006), "Education and Health: Evaluating Theories and Evidence", *NBER Working Paper 12352*, www.nber.org/papers/w12352

Datar A. and Sturm R. (2006) Childhood overweight and elementary school outcomes. *International Journal of Obesity* 30:1449-60.

Devaux M. and Sassi F. (2011) Social inequalities in obesity and overweight in eleven OECD countries. *The European Journal of Public Health 2011*; doi: 10.1093/eurpub/ckr058.

Fu, W.J. (2000), "Ridge Estimator in Singular Design with Application to Age-Period-Cohort Analysis of Disease Rates", *Communications in Statistics-Theory and Method,* vol. 29, pp. 263-278.

Fu, W. J. and P. Hall (2004), "Age-Period-Cohort Analysis: Structure of Estimators, Estimability, Sensitivity and Asymptotics", *Journal of the American Statistical Association*, under review.

Fu, W.J. and T.E. Rohan (2004), "Age-Period-Cohort Analysis: Consistent Estimation by the Intrinsic Estimator", *Journal of the American Statistical Association*, under review.

Goldstein, H. (1986), "Multilevel Mixed Linear Model Analysis Using Iterative Generalized Least Squares", *Biometrika*, 73, pp. 43-56.

Gortmaker, S. L. *et al.* (1993), "Social and Economic Consequences of Overweight in Adolescence and Young Adulthood", *The New England Journal of Medicine*, vol. 329(14), pp. 1008-12.

Grabner M. (2009) The Causal Effect of Education on Obesity: Evidence from Compulsory Schooling Laws. Available at SSRN: http://ssrn.com/abstract=1505075 the 11 Feb. 2010

Grossman, M. and R. Kaestner (1997), "Effects of Education on Health", J.R. Behrman and N. Stacey (eds.), *The Social Benefits of Education*, University of Michigan Press, Ann Arbor, MI, pp. 69–123.

Grossman, M. (2000), "The Human Capital Model", A.J. Culyer and J.P. Newhouse (eds.), *Handbook of Health Economics*, vol. 1A, Elsevier, Amsterdam, pp. 347–408.

Haas, M. (2008), "Weigh Too Fat", UTS Speaks, Public Lecture 22 May 2008. Available on: www.chere.uts.edu.au/pdf/utspeaks_haas.pdf

Kemna, H. (1987), "Working Conditions and the Relationship between Schooling and Health", *Journal of Health Economics,* vol. 6, pp. 189-210.

Kenkel, D. S. (1991), "Health Behavior, Health Knowledge, and Schooling", *Journal of Political Economy*, vol. 99(2), pp. 287-305.

Kenkel, D. S., D. R. Lillard and A. D. Mathios (2006), "The Roles of High School Completion and GED Receipt in Smoking and Obesity", *NBER Working Papers 11990*, www.nber.org/papers/w11990

Knight, K. and W.J. Fu (2000), "Asymptotics for Lasso-type Estimators", *Annals of Statistics*, vol. 28, pp. 1356-1378.

Lleras-Muney, A. (2005). "The relationship between education and mortality in the U.S.," *Review of Economic Studies,* 72(1): 189-221.

Lochner, L. and Moretti, E. (2004). "The effect of education on crime: evidence from prison inmates, arrests, and self-reports," *American Economic Review,* 94(1): 155-189.

Longford, N.T. (1987), "A Fast Scoring Algorithm for Maximum Likelihood Estimation in Unbalanced Mixed Models with Nested Random Effects", *Biometrika*, 74, pp. 817–827.

Lundborg, P. (2008), "The Health Returns to Education - What Can We Learn from Twins?", *Tinbergen Institute Discussion Paper No. TI 08-027/3*, Available at SSRN: http://ssrn.com/abstract=1113685

K=McMahon, W.W. (2004). "The Social and External Benefits of Education," in International Handbook on the Economics of Education, Geraint and Jill Johnes, eds, Edward Elgar, Publishers.

OECD (2007), *Education at a Glance*, OECD, Paris

OECD/Sassi, Franco *et al*., (2009), "The Obesity Epidemic: Analysis of Past and Projected Future Trends in Selected OECD Countries", *OECD Health Working Paper No. 45, Directorate for Employment, Labour, and Social Affairs*, OECD, www.oecd.org/els/health/workingpapers

Raudenbush, S.W. and A.S. Bryk (1986), "A Hierarchical Model for Studying School Effects", *Sociology of Education*, 59, pp. 1-17.

Sánchez-Vaznaugh, E.V., I. Kawachi, S.V. Subramanian, B.N. Sánchez, D. Acevedo-Garcia (2009), "Do Socioeconomic Gradients in Body Mass Index Vary by Race/Ethnicity, Gender and Birthplace?", *American Journal of Epidemiology*, vol. 169(9), pp.1102-12.

Sargent, J. D. and D. G. Blanchflower (1994), "Obesity and Stature in Adolescence and Earnings in Young Adulthood", *Archives of Pediatrics and Adolescent Med*icine, vol. 148, pp. 681-687.

Siegrist J., M. Marmot (2004), "Health Inequalities and the Psychosocial Environment - Two Scientific Challenges", *Social Science and Medicine*, vol. 58(8), pp. 1463-73.

Spasojevic, J. (2003), "Effects of Education on Adult Health in Sweden: Results from a Natural Experiment", PhD diss., Graduate Center, City University of New York.

Speakman, J. R. *et al.* (2005), "Associations between BMI, Social Strata and the Estimated Energy Content of Foods", *International Journal of Obesity*, vol. 29(10), pp. 1281-8.

Wardle, J., J. Waller and M.J. Jarvis (2002), "Sex Differences in the Association of Socioeconomic Status with Obesity", *American Journal of Public Health*, vol. 92, pp. 1299-1304

Webbink, D., N. G. Martin and P. M. Visscher (2008), "Does Education Reduce the Probability of Being Overweight?", *CPB Discussion Papers 102*, CPB Netherlands Bureau for Economic Policy Analysis.

Wolfe, B.L. and Haveman, R.H. (2002). “Social and nonmarket benefits from education in an advanced economy,” Conference Series [Proceedings], Federal Reserve Bank of Boston, June: 97-142.

World Health Organization (2003), "Diet, Nutrition and the Prevention of Excess Weight Gain and Obesity", Report of a joint WHO/FAO expert consultation, Geneva.

Yang, Y., W. Fu and K. Land (2004), "A Methodological Comparison of Age-Period Cohort Models: the Intrinsic Estimator and Conventional Generalized Linear Models", *Sociological Methodology*, Volume 34, Issue 1, pp. 75-110.

Yoon, Y.S., S.W. Oh and H.S. Park (2006), "Socio-Economic Status in Relation to Obesity and Abdominal Obesity in Korean Adults: A Focus on Sex Differences", Obesity (Silver Spring), vol. 14(5), pp. 909-19.

ANNEXES

Annex 1. Data description tables

Table A.1.1 Australia – National Health Survey

Australia		1989			1995			2001			2005		
		men	women	total	men	women	total	men	women	total	men	women	total
Total frequency		12,499	12,490	24,989	10,932	10,904	21,836	4,744	5,164	9,908	5,348	5,590	10,938
Age group	25-39	16.5%	16.7%	16.6%	15.3%	15.6%	15.4%	11.4%	12.8%	12.1%	12.4%	12.9%	12.7%
	30-34	16.2%	16.5%	16.4%	15.9%	16.1%	16.0%	13.9%	15.1%	14.4%	14.4%	15.0%	14.7%
	35-39	15.1%	15.4%	15.2%	15.2%	15.6%	15.4%	14.9%	15.4%	15.1%	13.9%	14.4%	14.1%
	40-44	14.6%	14.5%	14.5%	14.0%	14.0%	14.0%	15.2%	14.3%	14.8%	14.4%	14.6%	14.5%
	45-49	11.7%	11.1%	11.4%	12.9%	13.1%	13.0%	13.3%	13.2%	13.2%	13.2%	13.2%	13.2%
	50-54	9.4%	9.2%	9.3%	10.7%	10.1%	10.4%	13.1%	12.1%	12.6%	11.6%	11.3%	11.5%
	55-59	8.3%	8.2%	8.2%	8.7%	8.0%	8.4%	10.1%	9.3%	9.7%	11.3%	10.3%	10.8%
	60-64	8.2%	8.5%	8.3%	7.4%	7.4%	7.4%	8.2%	7.8%	8.0%	8.8%	8.2%	8.5%
Equivalized income	upper	31.6%	26.9%	29.3%	30.0%	26.0%	28.0%	31.3%	25.7%	28.6%	30.4%	24.4%	27.5%
	upper middle	25.6%	23.6%	24.6%	23.6%	22.3%	23.0%	22.5%	21.9%	22.2%	24.4%	21.0%	22.8%
	middle	20.0%	19.5%	19.8%	18.8%	18.5%	18.7%	19.4%	19.2%	19.3%	19.8%	21.1%	20.4%
	lower middle	13.9%	17.4%	15.6%	12.7%	16.5%	14.6%	12.9%	16.0%	14.4%	14.5%	17.1%	15.8%
	lower	8.9%	12.6%	10.7%	15.0%	16.6%	15.8%	13.9%	17.1%	15.5%	10.9%	16.4%	13.6%
Migrant	yes	31.2%	29.2%	30.2%	29.8%	29.2%	29.5%	29.2%	28.9%	29.1%	28.4%	28.9%	28.7%
	no	68.8%	70.8%	69.8%	70.2%	70.8%	70.5%	70.8%	71.1%	70.9%	71.6%	71.1%	71.3%
Obese	no	90.8%	89.6%	90.2%	86.4%	86.5%	86.4%	82.8%	81.8%	82.3%	78.1%	81.6%	79.8%
	yes	9.2%	10.4%	9.8%	13.6%	13.5%	13.6%	17.2%	18.2%	17.7%	21.9%	18.4%	20.2%
Over-weight	no	51.3%	67.0%	59.0%	43.8%	60.7%	52.0%	37.9%	55.7%	46.6%	32.2%	53.0%	42.3%
	yes	48.7%	33.0%	41.0%	56.2%	39.3%	48.0%	62.1%	44.3%	53.4%	67.8%	47.0%	57.7%
BMI classification	underweight	1.1%	5.1%	3.1%	0.9%	3.7%	2.3%	0.8%	3.4%	2.1%	0.5%	3.0%	1.7%
	normal	50.1%	61.9%	55.9%	42.9%	57.0%	49.8%	37.2%	52.2%	44.5%	31.7%	50.0%	40.6%
	overweight	39.5%	22.6%	31.2%	42.6%	25.7%	34.4%	44.8%	26.2%	35.7%	45.9%	28.6%	37.5%
	obese	9.2%	10.4%	9.8%	13.6%	13.5%	13.6%	17.2%	18.2%	17.7%	21.9%	18.4%	20.2%
Years of education	0-8	17.8%	17.9%	17.9%	13.8%	13.2%	13.5%	10.0%	8.3%	9.2%	6.7%	5.4%	6.1%
	9-11	65.8%	70.2%	68.0%	67.1%	71.2%	69.1%	67.6%	72.1%	69.8%	45.6%	44.0%	44.8%
	over 12	16.4%	11.9%	14.2%	19.2%	15.6%	17.4%	22.4%	19.6%	21.0%	47.7%	50.6%	49.1%

Table A.1.2 Canada – Canadian National Population Health Survey 1995 and Canadian Community Health Survey 2001-2005

Canada		1995			2001			2003			2005		
		men	women	total	men	women	total	men	women	total	men	women	total
Total frequency		5,009	5,560	10,569	35,044	36,852	71,896	33,154	34,911	68,065	33,471	35,495	68,966
Age group	25-39	13.9%	12.6%	13.2%	12.0%	11.5%	11.8%	12.0%	11.4%	11.7%	11.8%	11.6%	11.7%
	30-34	16.3%	17.5%	16.9%	13.3%	12.5%	12.9%	11.9%	12.0%	12.0%	11.7%	11.8%	11.7%
	35-39	17.1%	16.4%	16.8%	15.6%	15.9%	15.7%	15.0%	14.8%	14.9%	13.3%	13.1%	13.2%
	40-44	14.8%	14.7%	14.7%	16.5%	16.5%	16.5%	16.6%	16.4%	16.5%	16.4%	16.0%	16.2%
	45-49	13.2%	12.0%	12.6%	14.0%	14.7%	14.4%	13.6%	14.2%	13.9%	14.3%	14.9%	14.6%
	50-54	10.2%	9.9%	10.0%	12.2%	12.4%	12.3%	12.4%	12.8%	12.6%	12.5%	13.3%	12.9%
	55-59	7.7%	8.8%	8.2%	9.4%	9.2%	9.3%	10.6%	10.6%	10.6%	11.2%	10.9%	11.1%
	60-64	7.0%	8.1%	7.5%	7.0%	7.4%	7.2%	7.8%	7.8%	7.8%	8.8%	8.4%	8.6%
Equivalized income	upper	19.9%	16.5%	18.2%	37.7%	31.8%	34.8%	45.0%	37.7%	41.5%	54.2%	47.6%	51.0%
	upper middle	41.1%	37.9%	39.5%	37.1%	36.6%	36.8%	34.2%	35.9%	35.0%	26.0%	27.1%	26.6%
	middle	25.6%	28.3%	26.9%	17.1%	20.2%	18.6%	14.6%	17.7%	16.1%	12.9%	15.9%	14.4%
	lower middle	8.8%	11.4%	10.1%	4.8%	7.3%	6.0%	3.8%	5.6%	4.7%	3.0%	4.1%	3.5%
	lower	4.7%	5.9%	5.3%	3.3%	4.1%	3.7%	2.4%	3.0%	2.7%	3.9%	5.3%	4.5%
Minority	no				86.0%	85.9%	86.0%	84.3%	85.3%	84.8%	83.6%	84.0%	83.8%
	yes				14.0%	14.1%	14.0%	15.7%	14.7%	15.2%	16.4%	16.0%	16.2%
Obese	no	85.9%	86.1%	86.0%	82.5%	84.8%	83.6%	82.1%	84.2%	83.1%	81.2%	83.8%	82.5%
	yes	14.1%	13.9%	14.0%	17.5%	15.2%	16.4%	17.9%	15.8%	16.9%	18.8%	16.2%	17.5%
Over-weight	no	39.0%	59.2%	49.0%	40.4%	57.4%	48.7%	38.5%	57.0%	47.5%	37.7%	56.4%	46.7%
	yes	61.0%	40.8%	51.0%	59.6%	42.6%	51.3%	61.5%	43.0%	52.5%	62.3%	43.6%	53.3%
BMI classification	underweight	0.5%	2.6%	1.5%	0.9%	3.4%	2.1%	0.7%	3.1%	1.9%	0.7%	3.5%	2.0%
	normal	38.5%	56.6%	47.4%	39.5%	53.9%	46.6%	37.8%	54.0%	45.6%	37.1%	52.9%	44.7%
	overweight	46.9%	27.0%	37.1%	42.1%	27.5%	34.9%	43.6%	27.1%	35.6%	43.5%	27.5%	35.7%
	obese	14.1%	13.9%	14.0%	17.5%	15.2%	16.4%	17.9%	15.8%	16.9%	18.8%	16.2%	17.5%
Years of education	8	21.6%	21.1%	21.4%	18.1%	16.8%	17.4%	14.1%	13.3%	13.7%	12.4%	10.7%	11.6%
	12	14.9%	18.4%	16.6%	18.2%	21.3%	19.7%	18.0%	19.6%	18.7%	14.8%	15.8%	15.3%
	14	23.7%	25.0%	24.3%	6.9%	7.3%	7.1%	6.3%	6.6%	6.5%	7.1%	6.7%	6.9%
	17	39.8%	35.5%	37.7%	56.9%	54.6%	55.8%	61.6%	60.5%	61.1%	65.7%	66.8%	66.3%

Table A.1.3 Korea – Korean National Health and Examination Survey

Korea		1998			2001			2005		
		men	women	total	men	women	total	men	women	total
Total frequency		2941	3396	6337	2179	2706	4885	1822	2398	4220
Age group	25-39	13.6%	14.4%	14.0%	11.7%	12.7%	12.3%	8.3%	9.0%	8.7%
	30-34	15.4%	15.4%	15.4%	15.4%	16.0%	15.7%	13.7%	15.1%	14.5%
	35-39	16.0%	15.3%	15.6%	16.3%	16.6%	16.5%	13.3%	14.9%	14.2%
	40-44	15.3%	14.3%	14.7%	16.4%	16.6%	16.5%	15.3%	16.3%	15.9%
	45-49	11.1%	10.9%	11.0%	13.3%	11.7%	12.4%	17.0%	14.3%	15.5%
	50-54	9.9%	9.6%	9.7%	8.6%	9.4%	9.0%	10.4%	11.2%	10.8%
	55-59	9.6%	10.6%	10.1%	10.1%	8.4%	9.1%	11.9%	9.7%	10.6%
	60-64	9.1%	9.6%	9.4%	8.2%	8.6%	8.4%	10.2%	9.4%	9.7%
Equivalized income	upper	20.5%	25.6%	23.3%	22.7%	28.7%	26.0%	22.7%	27.4%	25.4%
	upper middle	21.8%	21.6%	21.7%	19.4%	18.7%	19.0%	21.5%	19.9%	20.6%
	middle	21.9%	19.1%	20.4%	22.9%	19.7%	21.1%	20.9%	18.6%	19.6%
	lower middle	20.4%	18.6%	19.4%	20.3%	18.7%	19.4%	20.4%	18.7%	19.5%
	lower	15.4%	15.0%	15.2%	14.7%	14.3%	14.5%	14.4%	15.4%	15.0%
Obese	no	98.2%	96.7%	97.4%	97.4%	96.5%	96.9%	96.8%	96.1%	96.4%
	yes	1.8%	3.3%	2.6%	2.6%	3.5%	3.1%	3.2%	3.9%	3.6%
Over-weight	no	72.2%	70.8%	71.4%	65.5%	70.9%	68.5%	61.6%	70.4%	66.6%
	yes	27.8%	29.2%	28.6%	34.5%	29.1%	31.5%	38.4%	29.6%	33.4%
BMI classification	underweight	3.2%	3.8%	3.5%	2.2%	4.7%	3.6%	2.7%	4.1%	3.5%
	normal	68.9%	67.0%	67.9%	63.3%	66.1%	64.9%	58.9%	66.2%	63.1%
	overweight	26.1%	25.9%	26.0%	31.9%	25.6%	28.4%	35.2%	25.8%	29.8%
	obese	1.8%	3.3%	2.6%	2.6%	3.5%	3.1%	3.2%	3.9%	3.6%
Years of education	6	16.8%	31.5%	24.7%	10.5%	21.0%	16.3%	9.9%	20.3%	15.8%
	9	15.5%	17.5%	16.6%	14.0%	15.4%	14.8%	12.6%	14.1%	13.4%
	12	40.2%	35.5%	37.7%	39.0%	41.9%	40.6%	37.7%	39.8%	38.9%
	16	24.2%	14.7%	19.1%	31.3%	20.7%	25.4%	35.0%	24.1%	28.8%
	17	3.2%	0.8%	1.9%	5.2%	1.1%	2.9%	4.8%	1.8%	3.1%

Table A.1.4 England – Health Survey for England

England		1991			1992			1993			1994			1995			1996			1997			1998		
		men	women	total	men	women	total	men	women	total	men	women	total	men	women	total	men	women	total	men	women	total	men	women	total
Total Frequency		937	1046	1983	1162	1242	2404	5000	5364	10364	4557	5073	9630	4536	5108	9644	4734	5303	10037	2514	2867	5381	4484	5221	9705
Age group	25-39	14.8%	13.4%	14.1%	15.6%	15.3%	15.4%	14.2%	14.1%	14.2%	14.0%	14.3%	14.1%	12.1%	13.6%	12.9%	12.1%	12.7%	12.5%	13.1%	12.6%	12.8%	12.3%	12.4%	12.4%
	30-34	14.6%	15.5%	15.1%	12.0%	12.9%	12.5%	14.3%	14.6%	14.4%	15.3%	15.0%	15.1%	15.6%	15.2%	15.4%	14.3%	14.7%	14.6%	13.9%	14.9%	14.4%	14.6%	14.4%	14.5%
	35-39	13.1%	12.4%	12.8%	13.6%	14.1%	13.9%	13.1%	13.9%	13.5%	15.1%	14.7%	14.9%	15.1%	13.6%	14.3%	13.9%	14.7%	14.3%	13.9%	13.2%	13.5%	14.4%	14.7%	14.6%
	40-44	14.3%	15.2%	14.8%	14.3%	14.2%	14.2%	12.9%	13.2%	13.0%	12.4%	12.8%	12.6%	13.0%	12.9%	13.0%	13.9%	12.8%	13.4%	13.6%	13.5%	13.5%	12.3%	12.4%	12.4%
	45-49	12.3%	11.5%	11.9%	14.0%	12.0%	13.0%	14.3%	13.6%	13.9%	12.7%	13.5%	13.1%	12.4%	12.9%	12.7%	14.1%	13.7%	13.9%	13.6%	13.9%	13.8%	13.4%	12.6%	13.0%
	50-54	10.0%	10.5%	10.3%	10.8%	10.8%	10.8%	10.6%	10.8%	10.7%	10.4%	10.3%	10.3%	11.4%	11.6%	11.6%	12.0%	12.1%	12.0%	12.1%	12.6%	12.4%	12.8%	13.4%	13.1%
	55-59	10.1%	10.5%	10.3%	9.2%	9.4%	9.3%	10.7%	9.9%	10.3%	9.8%	9.5%	9.7%	10.2%	10.5%	10.4%	9.6%	9.4%	9.5%	10.1%	9.8%	10.0%	9.7%	9.8%	9.8%
	60-64	10.7%	11.0%	10.8%	10.5%	11.4%	10.9%	9.9%	10.0%	9.9%	10.4%	9.9%	10.1%	10.1%	9.6%	9.8%	10.1%	9.8%	9.9%	9.7%	9.5%	9.6%	10.4%	10.3%	10.3%
Socioeconomic status	upper	7.6%	1.8%	4.5%	8.6%	1.8%	5.1%	10.0%	2.4%	6.0%	8.3%	2.3%	5.1%	8.4%	1.9%	5.0%	7.5%	2.2%	4.7%	8.0%	2.3%	5.0%	7.2%	2.4%	4.7%
	upper middle	32.9%	26.6%	29.6%	30.3%	25.7%	27.9%	30.3%	26.6%	28.4%	29.6%	26.3%	27.9%	31.1%	25.6%	28.2%	32.3%	25.9%	29.0%	31.3%	25.3%	28.1%	31.8%	25.6%	28.5%
	middle	40.8%	42.9%	41.9%	43.3%	47.8%	45.6%	43.9%	44.1%	44.0%	43.2%	44.0%	43.6%	42.7%	46.4%	44.6%	42.8%	45.0%	43.9%	42.4%	45.3%	43.9%	42.6%	44.3%	43.5%
	lower middle	14.3%	18.5%	16.5%	13.3%	15.8%	14.6%	11.7%	18.8%	15.4%	13.8%	19.8%	17.0%	13.1%	19.0%	16.2%	12.7%	19.7%	16.4%	14.7%	19.9%	17.5%	13.6%	19.7%	16.9%
	lower	4.5%	10.2%	7.5%	4.5%	8.9%	6.8%	4.1%	8.1%	6.2%	5.0%	7.6%	6.4%	4.7%	7.2%	6.0%	4.7%	7.2%	6.0%	3.6%	7.2%	5.5%	4.7%	7.9%	6.4%
Ethnicity	White	95.8%	96.1%	96.0%	95.3%	96.1%	95.7%	95.2%	95.3%	95.3%	95.2%	95.4%	95.3%	95.4%	95.6%	95.5%	94.6%	94.8%	94.7%	94.3%	94.8%	94.6%	95.0%	95.4%	95.2%
	Black	2.0%	2.0%	2.0%	1.2%	1.7%	1.5%	1.8%	2.0%	1.9%	1.4%	2.1%	1.7%	1.3%	1.6%	1.5%	1.8%	2.2%	2.0%	1.7%	1.9%	1.8%	2.1%	1.9%	2.0%
	Asian	2.1%	1.9%	2.0%	3.5%	2.2%	2.8%	3.0%	2.7%	2.9%	3.4%	2.5%	2.9%	3.3%	2.8%	3.0%	3.6%	3.0%	3.3%	4.1%	3.3%	3.6%	2.9%	2.7%	2.8%
Obese	no	85.5%	82.6%	84.0%	86.0%	82.0%	83.9%	85.3%	82.7%	83.9%	85.0%	82.3%	83.6%	83.1%	81.8%	82.4%	81.8%	80.9%	81.3%	81.0%	79.3%	80.1%	81.2%	78.3%	79.6%
	yes	14.5%	17.4%	16.0%	14.0%	18.0%	16.1%	14.7%	17.3%	16.1%	15.0%	17.7%	16.4%	16.9%	18.2%	17.6%	18.2%	19.1%	18.7%	19.0%	20.7%	19.9%	18.8%	21.7%	20.4%
Over-weight	no	42.7%	54.2%	48.8%	39.9%	53.5%	47.0%	38.3%	50.9%	44.8%	38.6%	51.2%	45.3%	36.8%	49.2%	43.4%	34.4%	47.0%	41.0%	33.4%	46.9%	40.6%	33.0%	45.5%	39.7%
	yes	57.3%	45.8%	51.2%	60.1%	46.5%	53.0%	61.7%	49.1%	55.2%	61.4%	48.8%	54.7%	63.2%	50.8%	56.6%	65.6%	53.0%	59.0%	66.6%	53.1%	59.4%	67.0%	54.5%	60.3%
BMI classification	under-weight	1.2%	2.0%	1.6%	0.9%	2.0%	1.5%	0.7%	1.4%	1.1%	0.6%	1.6%	1.1%	0.7%	1.4%	1.0%	0.6%	1.2%	0.9%	0.3%	1.5%	0.9%	0.6%	1.2%	0.9%
	normal	41.5%	52.2%	47.2%	39.1%	51.5%	45.5%	37.5%	49.5%	43.7%	38.1%	49.6%	44.2%	36.2%	47.8%	42.3%	33.8%	45.9%	40.2%	33.1%	45.4%	39.6%	32.4%	44.3%	38.8%
	over-weight	42.8%	28.4%	35.2%	46.0%	28.5%	37.0%	47.0%	31.8%	39.1%	46.4%	31.1%	38.3%	46.3%	32.6%	39.0%	47.4%	33.9%	40.3%	47.6%	32.4%	39.5%	48.2%	32.8%	39.9%
	obese	14.5%	17.4%	16.0%	14.0%	18.0%	16.1%	14.7%	17.3%	16.1%	15.0%	17.7%	16.4%	16.9%	18.2%	17.6%	18.2%	19.1%	18.7%	19.0%	20.7%	19.9%	18.8%	21.7%	20.4%
Years of education	8	11.4%	12.0%	11.7%	10.2%	9.3%	9.7%	8.5%	8.2%	8.3%	7.5%	6.8%	7.1%	6.7%	5.5%	6.1%	5.0%	5.2%	5.1%	3.7%	4.4%	4.1%	2.8%	2.8%	2.8%
	9	30.6%	29.3%	29.9%	28.4%	29.9%	29.2%	27.7%	29.2%	28.5%	25.2%	27.8%	26.5%	27.3%	29.1%	28.2%	26.8%	26.7%	26.7%	26.0%	29.1%	27.6%	27.8%	27.1%	27.4%
	10	27.2%	26.9%	27.0%	28.8%	28.8%	28.8%	29.4%	27.7%	28.5%	31.6%	28.4%	29.9%	30.6%	29.3%	29.9%	31.8%	31.4%	31.6%	31.5%	30.1%	30.7%	32.2%	31.8%	32.0%
	11	7.7%	9.3%	8.5%	7.0%	9.2%	8.1%	7.5%	8.7%	8.1%	7.5%	10.0%	8.8%	8.1%	10.0%	9.1%	7.5%	10.1%	8.8%	7.9%	9.4%	8.7%	7.5%	9.4%	8.5%
	12	5.1%	10.0%	7.7%	6.7%	10.0%	8.4%	7.2%	9.4%	8.3%	7.5%	10.2%	8.9%	7.5%	10.0%	8.8%	7.3%	9.3%	8.3%	8.5%	10.1%	9.4%	7.1%	11.0%	9.2%
	13	5.7%	6.8%	6.3%	7.7%	6.0%	6.8%	6.9%	8.9%	8.0%	8.3%	8.2%	8.2%	19.8%	16.0%	17.8%	21.4%	17.3%	19.2%	8.5%	7.1%	7.7%	8.4%	8.0%	8.2%
	15	12.3%	5.8%	8.9%	11.3%	6.8%	8.9%	12.9%	7.8%	10.3%	12.5%	8.7%	10.5%	0.1%	0.1%	0.1%	0.2%	0.1%	0.1%	14.0%	9.8%	11.8%	14.1%	9.8%	11.8%

England		1999			2000			2001			2002			2003			2004			2005		
		men	women	total	men	women	total	men	women	total	men	women	total	men	women	total	men	women	total	men	women	total
Total Frequency		2190	2494	4684	2186	2520	4706	4261	4976	9237	1971	2531	4502	4025	4745	8770	3027	3689	6716	1950	2342	4292
Age group	25-39	11.4%	10.2%	10.7%	11.0%	11.5%	11.3%	10.4%	10.7%	10.6%	10.2%	11.7%	11.0%	9.6%	9.3%	9.4%	11.5%	12.4%	12.0%	8.8%	10.0%	9.5%
	30-34	13.8%	14.8%	14.3%	15.2%	14.4%	14.7%	13.4%	12.7%	13.0%	12.3%	14.0%	13.3%	12.8%	12.3%	12.6%	15.8%	13.6%	14.6%	13.5%	11.3%	12.3%
	35-39	15.2%	15.4%	15.3%	15.0%	15.8%	15.4%	14.8%	15.6%	15.2%	15.4%	17.8%	16.7%	13.9%	15.1%	14.5%	15.2%	15.3%	15.3%	12.9%	12.9%	12.9%
	40-44	12.4%	13.8%	13.2%	13.8%	14.1%	14.0%	13.3%	13.8%	13.6%	15.6%	13.4%	14.4%	14.3%	14.7%	14.5%	14.9%	15.7%	15.3%	11.9%	14.9%	13.6%
	45-49	12.9%	12.1%	12.4%	10.7%	11.9%	11.3%	12.1%	12.3%	12.2%	11.6%	11.1%	11.3%	11.9%	11.9%	11.9%	11.7%	12.4%	12.1%	13.6%	14.1%	13.9%
	50-54	13.2%	15.2%	14.2%	12.9%	12.7%	12.8%	13.8%	13.9%	13.8%	12.2%	11.8%	12.0%	12.6%	11.7%	12.1%	11.3%	10.8%	11.0%	13.4%	11.9%	12.6%
	55-59	11.5%	8.9%	10.1%	11.6%	10.7%	11.1%	12.1%	11.6%	11.8%	12.1%	11.6%	11.8%	13.9%	14.2%	14.1%	9.8%	9.8%	9.8%	13.6%	13.3%	13.4%
	60-64	9.7%	9.6%	9.7%	9.8%	9.0%	9.4%	10.1%	9.4%	9.7%	10.5%	8.7%	9.5%	10.9%	10.9%	10.9%	9.8%	10.0%	9.9%	12.2%	11.6%	11.8%
Socioeconomic status	upper	9.4%	2.1%	5.5%	7.8%	2.1%	4.8%	7.8%	2.7%	5.0%	9.1%	3.6%	6.0%	8.4%	3.3%	5.6%	7.4%	4.1%	5.6%	8.6%	3.5%	5.8%
	upper middle	31.6%	26.9%	29.1%	32.4%	30.1%	31.2%	33.2%	29.8%	31.4%	32.1%	30.6%	31.3%	33.6%	32.5%	33.0%	32.0%	31.6%	31.8%	35.5%	33.7%	34.6%
	middle	43.6%	45.9%	44.8%	42.6%	43.1%	42.9%	41.4%	42.1%	41.8%	41.7%	41.8%	41.8%	41.0%	39.7%	40.3%	40.2%	37.6%	38.8%	39.1%	40.3%	39.7%
	lower middle	12.4%	18.6%	15.7%	13.2%	17.9%	15.7%	13.4%	19.7%	16.8%	13.5%	19.0%	16.6%	13.3%	19.2%	16.5%	16.4%	21.6%	19.3%	12.4%	17.5%	15.2%
	lower	3.0%	6.5%	4.8%	4.0%	6.7%	5.5%	4.2%	5.7%	5.0%	3.5%	4.9%	4.3%	3.7%	5.2%	4.5%	4.0%	5.0%	4.5%	4.4%	5.0%	4.7%
Ethnicity	White	94.2%	94.9%	94.6%	94.2%	94.4%	94.3%	94.8%	95.0%	94.9%	94.1%	94.1%	94.1%	93.6%	94.0%	93.8%	58.3%	60.9%	59.8%	93.6%	93.9%	93.8%
	Black	1.6%	1.7%	1.7%	1.4%	1.7%	1.6%	1.4%	1.8%	1.6%	1.4%	2.1%	1.8%	1.9%	2.0%	2.0%	13.2%	14.3%	13.8%	1.1%	1.8%	1.5%
	Asian	4.1%	3.4%	3.8%	4.4%	3.9%	4.1%	3.8%	3.2%	3.5%	4.5%	3.9%	4.1%	4.5%	4.0%	4.2%	28.4%	24.8%	26.4%	5.2%	4.3%	4.7%
Obese	no	79.7%	78.2%	78.9%	77.3%	78.8%	78.1%	77.2%	75.2%	76.2%	76.0%	76.0%	76.0%	75.7%	76.2%	76.0%	78.4%	74.2%	76.1%	74.2%	74.5%	74.3%
	yes	20.3%	21.8%	21.1%	22.7%	21.2%	21.9%	22.8%	24.8%	23.8%	24.0%	24.0%	24.0%	24.3%	23.8%	24.0%	21.6%	25.8%	23.9%	25.8%	25.5%	25.7%
Over-weight	no	33.1%	44.8%	39.3%	29.2%	45.9%	38.1%	28.5%	42.7%	36.2%	29.5%	42.5%	36.8%	28.8%	42.6%	36.3%	33.3%	39.7%	36.8%	28.5%	41.8%	35.7%
	yes	66.9%	55.2%	60.7%	70.8%	54.1%	61.9%	71.5%	57.3%	63.8%	70.5%	57.5%	63.2%	71.2%	57.4%	63.7%	66.7%	60.3%	63.2%	71.5%	58.2%	64.3%
BMI classification	under-weight	0.7%	1.1%	0.9%	0.5%	1.3%	0.9%	0.6%	1.1%	0.9%	0.7%	1.1%	0.9%	0.6%	1.1%	0.9%	0.9%	1.2%	1.1%	0.3%	1.0%	0.7%
	normal	32.4%	43.7%	38.4%	28.6%	44.6%	37.2%	28.0%	41.6%	35.3%	28.8%	41.4%	35.9%	28.3%	41.5%	35.4%	32.4%	38.4%	35.7%	28.3%	40.7%	35.1%
	over-weight	46.6%	33.4%	39.6%	48.1%	33.0%	40.0%	48.7%	32.5%	40.0%	46.5%	33.5%	39.2%	46.8%	33.6%	39.7%	45.1%	34.5%	39.3%	45.6%	32.7%	38.6%
	obese	20.3%	21.8%	21.1%	22.7%	21.2%	21.9%	22.8%	24.8%	23.8%	24.0%	24.0%	24.0%	24.3%	23.8%	24.0%	21.6%	25.8%	23.9%	25.8%	25.5%	25.7%
Years of education	8	3.2%	2.8%	3.0%	3.2%	2.3%	2.8%	2.6%	2.2%	2.4%	2.4%	1.8%	2.0%	2.4%	1.9%	2.1%	3.9%	5.4%	4.7%	2.2%	1.6%	1.9%
	9	26.2%	26.9%	26.6%	24.1%	21.1%	22.5%	23.2%	23.7%	23.4%	22.0%	22.0%	22.0%	21.4%	21.7%	21.6%	14.7%	15.7%	15.3%	20.0%	19.8%	19.9%
	10	32.3%	31.2%	31.7%	30.6%	32.4%	31.6%	31.9%	32.1%	32.0%	32.8%	29.7%	31.1%	32.4%	30.9%	31.6%	25.4%	25.0%	25.2%	30.6%	30.8%	30.7%
	11	6.7%	10.1%	8.5%	8.2%	9.4%	8.9%	7.8%	9.9%	9.0%	7.5%	9.7%	8.7%	7.2%	9.7%	8.5%	7.8%	9.8%	8.9%	7.6%	10.7%	9.3%
	12	7.7%	10.0%	8.9%	7.2%	11.7%	9.6%	8.1%	11.3%	9.8%	8.7%	11.8%	10.4%	8.8%	11.4%	10.2%	9.1%	11.6%	10.5%	8.9%	11.6%	10.3%
	13	8.6%	8.3%	8.5%	10.7%	10.6%	10.6%	10.0%	9.7%	9.8%	10.1%	11.2%	10.7%	10.1%	10.5%	10.3%	16.4%	14.8%	15.5%	11.2%	9.1%	10.0%
	15	15.2%	10.7%	12.8%	15.9%	12.4%	14.0%	16.4%	11.2%	13.6%	16.5%	13.8%	15.0%	17.7%	13.9%	15.6%	22.7%	17.7%	20.0%	19.6%	16.5%	17.9%

Annex 2. Regression analysis related to estimates in Figures 2 and 3

Logistic regression was used to estimate the likelihood of obesity associated with different lengths of time in education for both genders.

Australia	Dependant variable: obesity status	
	Odds ratios	*Significance*
Age		
25-29	ref.	
30-34	1.287	***
35-39	1.325	***
40-44	1.450	***
45-49	1.717	***
50-54	1.752	***
55-59	1.604	***
60-64	1.536	***
Year of survey	1.062	***
Women	1.027	
Years of education - Men		
8	ref.	
12	0.738	***
14	0.568	***
Years of education - Women		
8	ref.	
12	0.700	***
14	0.462	***
SES		
highest	ref.	
middle-high	1.157	***
middle	1.132	***
middle-low	1.517	***
lowest	1.381	***
Obs.	67671	
Prob > chi2	0.000	
Pseudo R2	0.032	

Canada	Dependant variable: obesity status	
	Odds ratios	*Significance*
Age		
25-29	ref.	
30-34	1.091	*
35-39	1.140	***
40-44	1.180	***
45-49	1.391	***
50-54	1.538	***
55-59	1.543	***
60-64	1.490	***
Year of survey	1.039	***
Women	0.956	
Years of education - Men		
8	ref.	
12	0.848	***
14	0.867	**
17	0.709	***
Years of education - Women		
8	ref.	
12	0.754	***
14	0.896	
17	0.599	***
SES		
highest	ref.	
middle-high	1.141	***
middle	1.136	***
middle-low	1.151	***
lowest	1.207	***
Obs.	219496	
Prob > chi2	0.000	
Pseudo R2	0.0124	

England	Dependant variable: obesity status	
	Odds ratios	*Significance*
Age	1.064	***
Age squared	0.999	***
Year of survey	1.058	***
Women	1.368	***
Years of education - Men		
8	ref.	
9	0.956	
10	0.882	**
11	0.788	***
12	0.726	***
13	0.706	***
15	0.558	***
Years of education - Women		
8	ref.	
9	0.792	***
10	0.677	***
11	0.599	***
12	0.565	***
13	0.558	***
15	0.353	***
SES		
highest	ref.	
middle-high	1.235	***
middle	1.199	***
middle-low	1.347	***
lowest	1.440	***
Obs.	104143	
Prob > chi2	0.000	
Pseudo R2	0.0266	

Korea	Dependant variable: obesity status	
	Odds ratios	*Significance*
Age	0.973	
Age square	1.000	
Year of survey	1.066	***
Women	3.968	***
Years of education - Men		
6	ref.	
9	1.601	
12	1.649	
16	1.509	
17	1.909	
Years of education - Women		
6	ref.	
9	1.007	
12	0.418	***
16	0.195	***
17	1.3E-07	***
SES		
highest	ref.	
middle-high	0.967	
middle	1.001	
middle-low	1.055	
lowest	1.217	
Obs.	15242	
Prob > chi2	0.000	
Pseudo R2	0.026	

Linear regression was used to estimate BMI level associated with different lengths of time in education for both genders.

Australia	Dependant variable: BMI	
	Estimates	*Significance*
Age		
25-29	ref.	
30-34	0.523	***
35-39	0.695	***
40-44	1.006	***
45-49	1.422	***
50-54	1.575	***
55-59	1.575	***
60-64	1.454	***
Year of survey	0.123	***
Women	-0.554	***
Years of education - Men		
8	ref.	
12	-0.351	***
14	-0.883	***
Years of education - Women		
8	ref.	
12	0.239	***
14	0.867	***
SES		
highest	ref.	
middle-high	0.184	***
middle	0.143	**
middle-low	0.538	***
lowest	0.254	***
Obs.	67671	
Prob > F	0.000	
Pseudo R2	0.0709	

England	Dependant variable: BMI	
	Estimates	*Significance*
Age	0.183	***
Age squared	-0.001	***
Year of survey	0.120	***
Women	0.503	***
Years of education - Men		
8	ref.	
9	0.027	
10	-0.071	
11	-0.312	**
12	-0.390	***
13	-0.569	***
15	-0.948	***
Years of education - Women		
8	ref.	
9	-0.603	***
10	-1.028	***
11	-1.401	***
12	-1.598	***
13	-1.622	***
15	-2.647	***
SES		
highest	ref.	
middle-high	0.332	***
middle	0.196	***
middle-low	0.434	***
lowest	0.467	***
Obs.	104143	
Prob > F	0.000	
Pseudo R2	0.0503	

Canada	Dependant variable: BMI	
	Estimates	*Significance*
Age		
25-29	ref.	
30-34	0.496	***
35-39	0.651	***
40-44	0.847	***
45-49	1.303	***
50-54	1.638	***
55-59	1.733	***
60-64	1.552	***
Year of survey	0.078	***
Women	-0.749	***
Years of education - Men		
8	ref.	
12	-0.128	
14	-0.140	
17	-0.506	***
Years of education - Women		
8	ref.	
12	-0.801	***
14	-0.725	***
17	-1.398	***
SES		
highest	ref.	
middle-high	0.148	***
middle	0.057	
middle-low	0.036	
lowest	-0.091	
Obs.	219496	
Prob > F	0.000	
Pseudo R2	0.0514	

Korea	Dependant variable: BMI	
	Estimates	*Significance*
Age	0.223	***
Age square	-0.002	***
Year of survey	0.065	***
Women	1.300	***
Years of education - Men		
6	ref.	
9	0.487	***
12	0.739	***
16	0.922	***
17	1.379	***
Years of education - Women		
6	ref.	
9	0.042	
12	-1.167	***
16	-2.223	***
17	-2.584	***
SES		
highest	ref.	
middle-high	-0.184	**
middle	-0.104	
middle-low	-0.124	
lowest	-0.294	***
Obs.	15704	
Prob > F	0.000	
Pseudo R2	0.0806	

Annex 3. Regression analysis related to estimates in Figures 4 to 6

Logistic regression was used to estimate the likelihood of obesity associated with different lengths of time in education for both genders and by ethnicity/minority status.

Table A.3.1: Australia

Australia - men	**Dependant variable: obesity status**	
	Odds ratios	*Significance*
Age		
25-29	ref.	
30-34	1.259	**
35-39	1.396	***
40-44	1.559	***
45-49	1.715	***
50-54	1.735	***
55-59	1.475	***
60-64	1.435	***
Year of survey	1.070	***
Years of education - Migrant		
8	ref.	
12	0.580	***
14	0.373	***
Years of education - Non-migrant		
8	ref.	
12	0.693	*
14	0.576	***
SES		
highest	ref.	
middle-high	1.115	*
middle	0.973	
middle-low	1.389	***
lowest	1.170	**
Obs.	33523	
Prob > chi2	0.000	
Pseudo R2	0.0357	

Australia - women	**Dependant variable: obesity status**	
	Odds ratios	*Significance*
Age		
25-29	ref.	
30-34	1.369	***
35-39	1.347	***
40-44	1.479	***
45-49	1.927	***
50-54	1.998	***
55-59	1.969	***
60-64	1.841	***
Year of survey	1.050	***
Years of education - Migrant		
8	ref.	
12	0.675	***
14	0.408	***
Years of education - Non-migrant		
8	ref.	
12	0.878	
14	0.729	***
SES		
highest	ref.	
middle-high	1.247	***
middle	1.409	***
middle-low	1.784	***
lowest	1.760	***
Obs.	34148	
Prob > chi2	0.000	
Pseudo R2	0.0367	

Table A.3.2. Canada

Canada - men	Dependant variable: obesity status	
	Odds ratios	*Significance*
Age		
25-29	ref.	
30-34	1.222	***
35-39	1.203	***
40-44	1.197	***
45-49	1.366	***
50-54	1.471	***
55-59	1.475	***
60-64	1.323	***
Year of survey	1.030	***
Years of education - Non-minority		
8	ref.	
12	0.880	***
14	0.869	***
17	0.735	***
Years of education - Minority		
8	ref.	
12	0.639	***
14	0.761	***
17	0.467	***
SES		
highest	ref.	
middle-high	0.988	
middle	0.941	**
middle-low	0.944	
lowest	0.875	***
Obs.	101113	
Prob > chi2	0.000	
Pseudo R2	0.0075	

Canada - women	Dependant variable: obesity status	
	Odds ratios	*Significance*
Age		
25-29	ref.	
30-34	1.193	***
35-39	1.160	***
40-44	1.210	***
45-49	1.441	***
50-54	1.689	***
55-59	1.646	***
60-64	1.474	***
Year of survey	1.053	***
Years of education - Non-minority		
8	ref.	
12	0.823	***
14	0.843	***
17	0.739	***
Years of education - Minority		
8	ref.	
12	0.529	***
14	0.926	
17	0.549	***
SES		
highest	ref.	
middle-high	1.323	***
middle	1.554	***
middle-low	1.825	***
lowest	1.821	***
Obs.	106698	
Prob > chi2	0.000	
Pseudo R2	0.0179	

Table A.3.3. England

England-men	Dependant variable: obesity status	
	Odds ratios	*Significance*
Age	1.089	***
Age squared	0.999	***
Year of survey	1.067	***
Years of education - White		
8	ref.	
9	0.869	**
10	0.781	***
11	0.701	***
12	0.626	***
13	0.640	***
15	0.471	***
Years of education - Black		
8	ref.	
9	0.517	***
10	0.618	***
11	0.537	**
12	0.664	
13	0.677	**
15	0.634	**
Years of education - Asian		
8	ref.	
9	0.517	***
10	1.169	***
11	0.970	***
12	1.153	***
13	0.826	***
15	0.762	***
SES		
highest	ref.	
middle-high	1.220	***
middle	1.185	***
middle-low	1.135	**
lowest	1.022	
Obs.	48558	
Prob > chi2	0.000	
Pseudo R2	0.0261	

England-women	Dependant variable: obesity status	
	Odds ratios	*Significance*
Age	1.042	***
Age squared	1.000	***
Year of survey	1.050	***
Years of education - White		
8	ref.	
9	0.886	**
10	0.774	***
11	0.696	***
12	0.656	***
13	0.615	***
15	0.414	***
Years of education - Black		
8	ref.	
9	1.631	***
10	1.650	***
11	1.582	***
12	1.396	**
13	1.862	***
15	0.984	
Years of education - Asian		
8	ref.	
9	1.631	
10	1.142	
11	0.704	***
12	0.831	***
13	0.762	***
15	0.615	***
SES		
highest	ref.	
middle-high	1.378	***
middle	1.347	***
middle-low	1.682	***
lowest	1.930	***
Obs.	55585	
Prob > chi2	0.000	
Pseudo R2	0.0312	

Annex 4. Multilevel models

This methodological annex gives a description of the multilevel model.

Let y_i be the value of the response variable *Y* for the individual *i*, and X_1 an independent covariate in a simple univariate model, the single-level regression equation for the individual *i* is given by

$$y_i = \beta_0 + \beta_1 x_{1i} + e_i \quad (1)$$

where β_0 is the intercept, β_1 the regression coefficient and the individual-level residuals e_i with $e_i \sim N(0, \sigma_e^2)$.

In order to evaluate the significance of a higher order aggregation of individuals in *n* groups on the single values y_i, the regression model in (1) can be written as

$$y_{ij} = \beta_{0j} + \beta_{1j} x_{1ij} + e_{ij} \quad (2)$$

where $j = 1,\ldots, n$ refers to the level-2 units (groups) and $i = 1,\ldots, N$, to the level-1 units (individuals).

Model in equation (2) is called *random intercept model* when the intercept β_0 in (1) becomes a random variable depending on the group *j*, that is

$$\beta_{0j} = \beta_0 + u_{0j} \quad (3)$$

with $u_{0j} \sim N(0, \sigma_{u0}^2)$ as group-level residuals. When considering also the regression coefficient β_1 as a random variable such as

$$\beta_{1j} = \beta_1 + u_{1j} \quad (4)$$

with $u_{1j} \sim N(0, \sigma_{u1}^2)$ and $cov(u_{0j}, u_{1j}) = \sigma_{u01}$, the model in equation (2) is called *random coefficient model* and can be written in the form

$$y_{ij} = \beta_0 + \beta_1 x_{1ij} + (u_{0j} + u_{1j} x_{1ij} + e_{ij}) \quad (5)$$

In equation (5) the response variable y_{ij} has been expressed as the sum of a fixed part and a random part within the brackets, where the covariate x_{1ij} in the random part of the model is usually substituted by z_{1ij} to make the distinction with the covariates in the fixed part. In model (5) both intercept and regression coefficients vary from group to group, so to explain the effect of the group's aggregation on the *Y* variable. The individual-level residuals e_{ij} are assumed to be independent from the group-level residuals u_{0j} and u_{1j}.

The *intra level-2 unit correlation* in random intercept models is given by

$$\rho = \frac{\sigma_{u0}^2}{\sigma_{u0}^2 + \sigma_e^2} \quad (6)$$

and measures the proportion of the total variance which is between-groups. The same correlation index in case of random coefficient models equals

$$\rho = \frac{\sigma_{u0}^2 + 2\sigma_{01} z_{1ij} + \sigma_{u1}^2 z_{1ij}^2}{\sigma_{u0}^2 + 2\sigma_{01} z_{1ij} + \sigma_{u1}^2 z_{1ij}^2 + \sigma_e^2} \quad (7)$$

The existence of a non-zero intra-group correlation indicates that traditional estimation procedures used in multiple regressions, such as ordinary least square, are not correct. For this reason, estimation methods for multilevel models include generalized least square techniques (Goldstein, 1986), Fisher scoring algorithm (Longford, 1987) or the expectation-maximization algorithm (Raudenbush and Bryk, 1986). The simple 2-level random coefficient model in (5) can be further extended by introducing more explanatory variables at either the individual or the group levels. Moreover, the number of nested levels can be increased when considering more aggregation stages.

In the case y_{ij} is a discrete response, the model is a hierarchical logistic model and the random intercept model is

$$y_{ij} = \beta_0 + \beta_1 x_{1i} + (u_{0j} + e_{ij}) \quad (8)$$

with e_{ij} having logistic distribution and the individual-level variance σ^2_e is equal to $\pi^2/3$. So, the intra-class correlation is (with σ^2_{u0} the group-level variance)

$$\rho = \frac{\sigma_{u0}^2}{\sigma_{u0}^2 + \frac{\pi^2}{3}} \quad (9)$$

Chapter 3.

Social Disparities in Hazardous Alcohol Use: Self-report Bias May Lead to Incorrect Estimates

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ABSTRACT

Background: Self-report bias in surveys of alcohol consumption is widely documented, however, less is known about the distribution of such bias by socioeconomic status (SES) and about the possible impact on social disparities. This study aims to assess how correcting alcohol consumption data for self-report bias may affect estimates of social disparities in hazardous drinking (HD).

Methods: National survey data from 13 countries: Canada, England, Finland, France, Germany, Hungary, Ireland, Japan, Korea, New Zealand, Spain, Switzerland and USA, are used to examine social disparities in HD by SES and education level. Defining HD as drinking above 3 drinks per day for men, and 2 for women, social disparities were assessed by calculating country-level concentration indexes. Aggregate consumption data were used to correct survey-based estimates for self-report bias.

Results: Survey data show that more-educated women are more likely than less-educated women to engage in HD, while the opposite is observed in men in most countries. Large discrepancies in alcohol consumption between survey-based and aggregate estimates were found. Correcting for self-report bias increased estimates of social disparities in women, and decreased them in men, to the point that gradients were reversed in several countries (from higher rates in low education/SES men to an opposite pattern).

Conclusion: This study provides evidence of a likely mis-estimation of social disparities in HD, in both men and women, due to self-report bias in alcohol consumption surveys. This study contributes to a better knowledge of the social dimensions of HD and to the targeting of alcohol policies.

INTRODUCTION

Harmful alcohol use is responsible each year for about 2.5 million premature deaths worldwide.[1] To design appropriate public health policies, it is important to understand how far hazardous drinking (HD) spreads and which population groups are the most affected. A number of studies examined differences in HD by gender and socioeconomic background; however findings are not always consistent, largely due to the variety of HD outcomes used. There is evidence of a negative association between education and heavy drinking.[2-4] However, evidence on the relationship between socioeconomic status (SES) and HD is less consistent. A US study shows that heavy episodic drinking is more prevalent among people with higher incomes. However heavy episodic drinkers with lower incomes do so more frequently and consume larger numbers of drinks.[5]

Men are more often drinkers and consume more alcohol than women.[2] Gender differences in drinking are intertwined with educational and socioeconomic gradients in harmful drinking. A British study shows a strong positive link between educational attainment and drinking frequency as well as life-time drinking problems in women, but no such association in men.[6] International studies show that men with lower education are more likely to be hazardous and heavy episodic drinkers,[2,7-8] whereas more educated women are more at risk but with some exceptions, e.g. Czech Republic, Finland, Hungary, and Sweden.[2,7,9] It is worth noting that despite the multi-country framework, there was no attempt to gauge and compare the size of social disparities across countries in the above studies.

Besides, there is evidence that people in lower SES groups and ethnic minority groups are more affected by alcohol-related harms. In a number of countries, the worst-off have higher rates of alcohol-related problems and mortality than the better-off,[10] even for the same level of drinking.[11-12] These disparities - observed for equal alcohol consumption- are possibly the results of other social or environmental dimensions surrounding problems such as health education or access to health care. These findings along with the picture of the social gradient in HD as described above may question about the reliability of drinking measurement in surveys and raise the issue of self-report bias.

Survey-based data on alcohol consumption are likely affected by measurement bias including underreporting by survey respondents,[13-17] and selection bias in survey sampling that may under-sample groups of people with high alcohol consumption (e.g. students, alcohol dependent people), and may not

include at all people the most at risk of harmful drinking (e.g., homeless).[13,15] Drinking levels reported in household-based surveys have been shown to account for only 40-60% of alcohol sales.[18-19]

Alternative data sources on alcohol consumption exist, but they generally do not permit to analyse drinking behaviours by SES. WHO produces aggregate estimates of adult per capita alcohol consumption (APC) including recorded consumption -based on sales, tax, international trade, and survey data- and unrecorded consumption adjusting for homemade or illegally produced alcohol, smuggled alcohol, alcohol for industrial and medical use, and tourist consumption.[1] The latter accounts for nearly 30% of total worldwide adult consumption. These aggregate APC estimates provide the most reliable information to determine broad national trends and draw country profiles of alcohol consumption. However, their aggregate nature does not permit identification and examination of individual drinking behaviours.

The drivers of mis-reporting alcohol consumption associated to survey design have been largely explored,[19,20-21] whereas predictors at the individual level such as level of drinking and socio-demographic factors need more attention. On one hand, a number of studies suggest that self-report bias and non-response bias may be larger among heavy drinkers.[22-25] On the other hand, differences in self-reporting consumption are suspected in relation to social and educational backgrounds, however data drawn from national representative surveys do not collect exact measures of alcohol intake that would permit to accurately assess self-report bias in different population groups. To our knowledge, there is no evidence on the distribution of the self-report bias by population group and how far self-reporting alcohol consumption may impact on social disparities in drinking.

This paper aims to assess the potential effect of correcting for self-report bias in alcohol consumption on social disparities. The study focuses on social disparities in HD using national health survey data from 13 OECD countries. It contributes to the existing research in two ways. First, it provides a summary index of inequality making cross-country comparison easier. Second, it proposes to correct alcohol consumption for self-reporting following Rehm's approach,[16] and to assess for the first time how correcting for self-report bias may affect social disparities in drinking.

METHODS

Data

Data are gathered from national health surveys, or alcohol and drug use surveys, for 13 OECD countries: Canada, England, Finland, France, Germany, Hungary, Ireland, Japan, Korea, New Zealand, Spain, Switzerland, and the USA. They provide the most detailed information currently available on individual characteristics combined with drinking behaviours, either measured over the week prior to the interview in 5 countries (Canada, Finland, Hungary, Japan, and Switzerland) or based on frequency and quantity of alcohol consumed on a typical drinking day in the 8 remaining countries. Table 1 presents the list of surveys.

Table 1. List of data sources

Country	Survey name	Available survey waves	Frequency Men	Frequency Women
Canada	Canadian Community Health Survey	2009/10	82050	97368
England	Health Survey for England	2011	7730	9409
Finland	Finrisk	2007	3328	3478
France	Enquête Santé et Protection Sociale	2008, 2010	8233	8772
Germany	Epidemiological Survey on Substance Abuse	2006, 2009	4836	5998
Hungary	European Health Interview Survey	2009	1750	1981
Ireland	Survey on Lifestyle And Nutrition	2007	3181	4229
Japan	National Survey on Alcohol Drinking and Lifestyle	2003, 2008	2760	2732
Korea	Korean National Health and Nutrition Examination Survey	2008	5752	7453
New Zealand	National Health Survey	2006/07	4181	5506
Spain	Encuesta Nacional de Salud de Espana	2006	10371	12473
Switzerland	Swiss Health Survey	2007	7422	8996
USA	National Health and Nutrition Examination Survey	2009/10	4376	4422

Cross-country comparisons of drinking behaviours are challenging because of the lack of international consensus in the definition of a standard drink[16] and drinking limits.[26] In this study, the quantity of alcohol consumed (expressed in grams of pure alcohol per week) was derived from the number of standard drinks as defined in each country. Combining information on quantity and frequency of alcohol consumption permits to calculate quantity per week. People who did not consume alcohol in the past 12 months are considered as abstainers and are assigned 0 gram per week. HD threshold is defined as 140 grams of pure alcohol per week (or 2 drinks per day) for women and 210 grams per week (or 3 drinks per day) for men. This measure refers to the limits above which people are at risk for their health as defined

[16] A half-pint of beer, a glass of wine, a shot of whisky are all examples of one standard drink. A standard drink contains the same amount of alcohol regardless of the container size or the type of alcoholic beverage. However the definition of a standard drink differs across countries. For instance, the content of a standard drink is 13.6 grams of pure alcohol in Canada, 14 grams in USA and 10 grams in France.

in a number of countries. A common set of individual characteristics includes gender, age, ethnicity, marital status, working status, smoking, education level and socioeconomic status (SES) (occupation-based or income level) (further described in Annex 1). Since this study focuses on the relationship between education and HD, the analysis covers adults aged 25 and over, who have finished their education, in order to address endogeneity problems. It is worth noting that the maximum age is 65 in Germany and 75 in Finland due to inclusion criteria in surveys. All analyses use sampling weights. All analyses are undertaken with Stata 13.

Identifying within-country disparities

Logistic regressions are used to assess within-country disparities in HD by education level and SES while controlling for a range of covariates. Gender-specific regressions -as noted in equation [1]- are performed for each country.

$$Logit(p) = \alpha_0 + \alpha_1 age_i + \alpha_2 age_i^2 + \alpha_3 mar_i + \alpha_4 eth_i + \alpha_5 smk_i + \alpha_6 wrk_i + \alpha_7 edu_i + \alpha_8 ses_i + \varepsilon_i \quad [1]$$

where p is the probability of HD, age_i denotes age of individual i, mar_i marital status, eth_i ethnicity (available in England, New Zealand and the US), smk_i smoking, and wrk_i working status. The education (edu_i) and SES (ses_i) variables are entered one by one, then together in the model. Adjusted probabilities by education level and SES are derived after fitting the statistical model. They represent the probability of being hazardous drinker for a typical man (or woman) aged 40 years-old and with all other covariates fixed at the sample mean (except education level and SES).

Measuring between-country disparities

To assess between-country disparities, it is necessary to use an aggregate index of inequality in order to take into account differences in the size and nature of socioeconomic groups in different countries. This study uses the Wagstaff's concentration index (WCI) to quantify education-related and SES-related disparities. Calculation for WCI is described in Annex 1.

Correcting for self-reported alcohol consumption

Survey-based alcohol consumption is corrected to reflect the overall APC following Rehm's method.[16] This approach aims to correct survey data using aggregate APC data by modelling the upshifted distribution of

alcohol consumption. It relies on the assumption that the proportion of abstainers as measured in the survey is accurate because only drinkers can be adjusted, and that the alcohol consumption is gamma-distributed. The procedure uses as a factor of correction the coverage rate of total alcohol consumption as measured in the survey data over the overall APC (Table 2). A single factor is defined for all genders and age groups since aggregate APC data are not available by gender and age. While aggregate data are calculated for population above age 15, survey data may cover different age groups (e.g. people aged 25-74 in Finland). More detail on the correction procedure is available in Annex 1. Once the correction is applied, new WCIs are computed.

Table 2. Factor of correction

Country	Recorded and unrecorded APC, litres per capita	APC, grams per week per capita (age 15+)	Survey-based consumption, grams per week	Coverage rate
Australia	10.6+0.1	165.1	86.6 (age 15+)	58%
Canada	8.2+2.0	156.9	36.4 (age 15+)	26%
Finland	10.5+2.8	204.6	62.9 (age 25-74)	34%
France	12.3+0.4	195.4	36.0 (age 18+)	20%
Germany	12.0+1.0	200.0	82.3 (age 18-65)	46%
Hungary	11.5+4.0	238.5	34.4 (age 16+)	16%
Ireland	13.4+1.0	221.5	60.0 (age 18+)	30%
Japan	7.3+0.2	115.4	69.2 (age 20+)	67%
Korea	12.1+3.0	232.3	56.3 (age 12+)	27%
New Zealand	9.2+0.5	149.2	46.3 (age 16+)	34%
Spain	11.4+1.4	196.9	38.3 (age 16+)	22%
Switzerland	10.5+0.5	169.2	70.9 (age 15+)	47%
United Kingdom*	10.7+1.7	190.8	70.1 (age 16+)	41%
United States	8.7+1.0	149.2	51.2 (age 20+)	38%

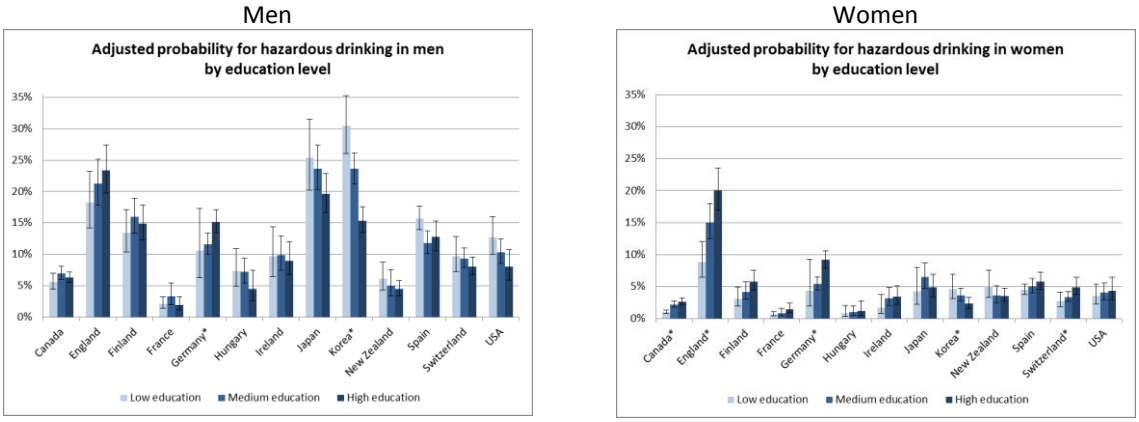
Note: (*) Survey data in the UK refers to England only.

RESULTS

Figure 1 shows the adjusted probabilities of HD in men and women by education level, all other things being equal. Corresponding results of social disparities by SES are displayed in Figure B1 in Annex 2. Levels of HD are low, especially among women in France and Hungary. Men with more education tend to engage less in HD than their less-educated counterpart, although the gradient is seldom significant. This pattern (referred as negative gradient) is observed in 9 out of 13 countries and the gradient is significant

in Korea only. Conversely, in Canada, England, Finland, and Germany, men with more education are more affected by HD, this gradient (referred as positive gradient) being significant in Germany only. The pattern for SES-related disparities is more mixed, with a positive gradient in 6 countries (significant in 3 countries) and a negative gradient in 7 countries (significant in Hungary only) (see Figure B1 in Annex 2). Regarding women, the prevalence of HD is lower than in men, and the pattern of inequality is clearer. The relationship between education level and HD is positive in 10 countries and significant in four of them (Canada, England, Germany and Switzerland) (Figure 1). Conversely, Japan, Korea and New Zealand display a negative relationship (significant in Korea). The pattern for SES-related inequalities is consistent, with 9 countries showing a significant positive gradient of inequality (see Figure B1 in Annex 2).

Figure 1. Adjusted probabilities of hazardous drinking by education level



Note: * means that the overall gradient is significant at 5%. In England, the probability of HD for men aged 40 years-old and all other characteristics fixed at the sample mean, is equal to respectively 18%, 21% and 23% in the low, medium and high education groups.

Figure 2 displays the WCI for HD by education level, before and after correcting for self-report bias. *Before correction*, in men, the pattern of inequality is mixed and its degree is generally small. Eight of the 13 studied countries present a positive index -indicating larger HD rates in men with lower education-, with Korea and the US showing the largest inequalities. In contrast, England and Germany show large degree of inequality in the reverse direction. Corresponding results by SES support these findings (see Figure B2 in Annex 2). For women, social disparities observed in 11 of 13 countries *before correction* suggest larger HD rates in women with higher education, with the largest inequalities in England and France. In contrast, Korea and New Zealand show a reverse gradient, indicating that less educated

women are more affected by HD. Results by SES confirm these findings, indicating larger inequalities in Canada and England (see Figure B2 in Annex 2). Comparison between genders shows a contrasting educational gradient in 7 countries (France, Hungary, Ireland, Japan, Spain, Switzerland, and USA), and similarly, a contrasting SES gradient in 6 countries (France, Hungary, Japan, Spain, Switzerland, and USA).

Figure 2. WCIs for hazardous drinking by education level, before and after correcting for self-report bias

Changes after correcting for self-report bias

Differences in WCIs before and after correction are graphically displayed in Figure 2 and reported in Table B1 in Annex 2. In men, in countries where the WCI was initially negative (e.g. England), the correction leads to a steeper gradient. In countries where the WCI was initially positive, the correction results in smaller disparities (e.g. New-Zealand), or even a reverse gradient (e.g. France). The before/after correction difference in WCIs is negative in men in all countries, indicating that the correction leads to a greater relative increase in rates of HD in men with higher education/SES. In women, the difference in WCIs is negative in most countries, magnifying the size of social disparities. Even when the difference caused by the correction is positive, this does not reverse the sign of the social gradient.

DISCUSSION

This paper shows that men and women with more education or higher SES often differ in their propensity to engage in HD. Higher-educated women are more likely than the lower educated to drink at risk while the opposite is observed in men in most countries. The degree of inequality varies between countries since social patterns of drinking are largely the result of cultural and environmental influences, and of government policies in place in the countries concerned. Larger social disparities in women are found in Canada, England and France, whereas larger social disparities in men (though the male gradient is opposite) are found in Korea and Hungary. The effect of correcting for self-report bias is consistent across countries and leads to larger increases in HD rates in people with higher education/SES. After correction, social disparities increased in women, and decreased in men, to the point that gradients were reversed in several countries (from higher rates in men with low education/SES to a reverse pattern).

Interpretation of findings

The negative relationship between SES and HD, frequently observed in men before correction, is in line with most findings on inequalities in unhealthy lifestyle habits (e.g. smoking, obesity), with a range of explanations including health information, time preferences, and intergenerational transmissions. Environmental factors may also contribute to explaining this gradient since higher alcohol outlets density -associated with greater levels of alcohol consumption-[27-28] is apparent in more disadvantaged urban areas in New Zealand and the United States.[29-30]

Conversely, the positive association between SES and HD largely observed in women and in both genders after correction, differs from the usual gradient in unhealthy lifestyle behaviours, confirming previous results.[31-32] Possible explanations for this gradient include individual's affluence, possible ill-health, change in women's social position, and social norms. First, individual's affluence and alcohol prices are important determinants of consumption. People with higher SES, and thus with higher incomes, tend to consume more alcohol and more frequently since they can afford it, although this is not consistently related with engaging in HD.[5] Second, people in lower-SES may consume less alcohol because of poorer health. This assumption was tested by adding controls for self-assessed health in the model. Results show that the coefficients associated to education and SES remain significant although slightly attenuated, suggesting that, for a given health status, disparities in HD across social groups persist. Third, the link between higher SES and higher propensity of HD is more often observed in women, contrary to men,

possibly related to changes in women's occupational status and position. Women with higher education who end up taking better-paid jobs involving higher degrees of responsibility may drink more heavily because they have more stress and more frequent occasions of socializing and going out with colleagues compared to their low-SES counterpart. Besides, these occasions being typically in masculine work environment, women are confronted to higher limits of drinking.[33] This assumption was tested on French data by disentangling women in high socioeconomic position in masculine work environment (in managerial /technical occupations) versus women in high socioeconomic position in less-masculine environment (in teaching /arts / health occupations). Findings confirmed that women in masculine work environment are more likely to drink heavily compared to women in less-masculine work environment. Finally, change in social norms may be analysed through the theory of social innovation diffusion suggesting that high-income people first appropriate innovative goods or behaviours -such as new drinking patterns- in a way to distinguish from other social groups.[34] After some time, the innovation spreads to all other population groups. In a second stage, once HD behaviour is common in all population groups and as the associated risks for health are spread, high-income people first start to stop HD. Generally, a time lag is observed between men and women -like for smoking some decades ago.[35] Adoption of HD by women to imitate men's behaviours can be seen as greater gender equity.[36] Under this assumption, our results suggest that in most countries men are in the second phase of the social innovation diffusion whereas women are in the first stage, and that female social disparities will resemble male disparities in the future.

Regarding self-report bias, this study showed that alcohol consumption estimated from survey data covers between 16 and 67% of the alcohol volume derived from aggregate sales data. These figures are consistent with previous reports,[13-14,37] and cast doubt on the reliability of alcohol consumption estimates from self-reported survey data. Finally, our correction for self-report bias resulted in larger increases in HD rates in people with higher education/SES. This can be explained by the fact that low-SES people are more often abstainers than high-SES people, and, since the correction is applied only to drinkers, more high-SES people than low-SES people end up crossing the HD threshold after correction. This clearly assumes that the higher prevalence of abstinence in people with lower education/SES reported in surveys can be trusted. In fact, this is supported by evidence based on purchase data, indicating that fewer low-SES than high-SES households purchase alcohol.[38] Our finding also raises questions on differences in the knowledge of drinking limit guidelines between SES groups. High-SES people may be better informed about these guidelines, and so, may more frequently report an average alcohol consumption just below the limit, explaining why they are more often crossing the HD threshold after correction.

Possible limitations

This study presents some limitations. First, comparability of results is limited due to the use of different national surveys that may be a source of data heterogeneity. Data are gathered from different national surveys, supposing differences in survey methodology, sampling, and questionnaires. Although lot of efforts was made to get the highest level of comparability across countries, some differences remain as indicated in the Methods section. Second, participation rate regarding questions on drinking is especially low in a number of countries. Survey design and questions formulation have an influence on quality of responses. As a consequence, results may be affected to different extents across countries. Third, the time span of five years in the study may be a source of limitation for comparison over time. Survey data from 2006 to 2011 were put together although the economic crisis and its impacts on job market may have influenced drinking behaviours. Fourth, the correction for self-report bias does not account for differences by socioeconomic group. Additional sources of information combining self-reported consumption and alcohol purchase or alcohol intake diary, stratified by socioeconomic group, would be useful although this type of data is not commonly available. Despite these limitations, this study gives some insights into differences in HD across population groups in 13 countries, and it assesses for the first time the potential effect of correcting for self-report bias on social disparities. This paper contributes to a better knowledge of the social dimensions of alcohol drinking and to the targeting of alcohol policies. It permits to identify the population groups the most at risk of HD and reveals gender differences in socioeconomic disparities. More importantly, this paper highlights large discrepancies in alcohol consumption between survey-based and aggregate data, and it suggests that neglecting self-report bias may lead to incorrect estimates of social disparities in HD.

REFERENCES

1 WHO (2011). Global status report on alcohol and health. World Health Organization 2011. Switzerland.

2 Bloomfield K, Grittner U, Kramer S, et al. Social inequalities in alcohol consumption and alcohol-related problems in the study countries of the EU concerted action 'Gender, Culture and Alcohol Problems: a Multi-national Study'. *Alcohol Alcohol* 2006;41(suppl.1):i26-i36.

3 Caldwell TM, Rodgers B, Clark C, et al. Lifecourse socioeconomic predictors of midlife drinking patterns, problems and abstention: findings from the 1958 British Birth Cohort Study. *Drug Alcohol Depend* 2008;95:269-78.

4 Casswell S, Pledger M, Hooper R. Socioeconomic status and drinking patterns in young adults. *Addiction* 2003;98:601-61.

5 Kanny D, Liu Y, Brewer RD. Binge Drinking - United States, 2009. CDC Health Disparities and Inequalities Report – United States 2011, Morbidity and Mortality Weekly Report 2011;60(Suppl):101-4.

6 Huerta MC, Borgonovi F. Education, Alcohol Use and Abuse among Young Adults in Britain. *Soc Sci Med* 2010;71(1):143-51.

7 Kuntsche S, Gmel G, Knibbe RA, et al. Gender and cultural differences in the association between family roles, social stratification, and alcohol use: A European cross-cultural analysis. *Alcohol Alcohol* 2006;41,Suppl.1,i37-i46.

8 Kerr WC, Greenfield TK, Bond J, et al. Age–period–cohort modelling of alcohol volume and heavy drinking days in the US National Alcohol Surveys: divergence in younger and older adult trends. *Addiction* 2009;104:27–37.

9 Helasoja V, Lahelma E, Prättälä R, et al. The sociodemographic patterning of drinking and binge drinking in Estonia, Latvia, Lithuania and Finland, 1994–2002. *BMC Public Health* 2007;7:241.

10 Najman JM, Williams GM, Room R. Increasing socioeconomic inequalities in male cirrhosis of the liver mortality: Australia 1981-2002. *Drug Alcohol Rev* 2007;26(3):273-8.

11 Mäkelä P, Paljärvi T. Do consequences of a given pattern of drinking vary by socioeconomic status? A mortality and hospitalisation follow-up for alcohol-related causes of the Finnish Drinking Habits Surveys. *J Epidemiol Commun Health* 2008;62:728–33.

12 Grittner U, Kuntsche S, Graham K, et al. Social Inequalities and Gender Differences in the Experience of Alcohol-Related Problems. *Alcohol Alcohol* 2012;47(5):597-605.

13 Stockwell T, Donath S, Cooper-Stanbury M, et al. Under-reporting of alcohol consumption in household surveys: A comparison of quantity-frequency, graduated-frequency, and recent recall. *Addiction* 2004;99:1024–1033.

14 Boniface S, Shelton N. How is alcohol consumption affected if we account for underreporting? A hypothetical scenario. *Eur J Public Health* 2013;23(6):1076–1081.

15 Meier PS, Meng Y, Holmes J, et al. Adjusting for unrecorded consumption in survey and per capita sales data: Quantification of impact on gender- and age-specific alcohol-attributable fractions for oral and pharyngeal cancers in Great Britain. *Alcohol Alcohol* 2013;48(2):241-249.

16 Rehm J, Kehoe T, Gmel G, et al. Statistical modeling of volume of alcohol exposure for epidemiological studies of population health: the US example. *Popul Health Metr* 2010;8:3.

17 Ely M, Hardy R, Longford NT et al. Methods of estimating individual levels of alcohol consumption in the general population. Alcohol Research UK. 2001.

18 Midanik L. The Validity of Self-Reported Alcohol Consumption and Alcohol Problems: A Literature Review. *Br J Addict* 1982;357–382.

19 Hill-McManus D, Angus C, Meng Y, et al. Estimation of usual occasion-based individual drinking patterns using diary survey data. *Drug Alcohol Depend* 2014;134:136-143.

20 Feunekes G, van't Veer P, van Staveren W, et al. Alcohol Intake Assessment: The Sober Facts. *Am J Epidemiol* 1999;150(1):105-112.

21 Ekholm O. Influence of the recall period on self-reported alcohol intake. *Eur J of Clin Nutr* 2004;58:60-63.

22 Townshend JM, Dukat T. Patterns of alcohol drinking in a population of young social drinkers: a comparison of questionnaire and diary measures. *Alcohol Alcohol* 2002;37(2):187-92.

23 Lemmens P, Knibbe RA, Tan F. Weekly recall and diary estimates of alcohol consumption in a general population survey. *J Stud Alcohol* 1988;49:131–135.

24 Zhao J, Stockwell T, Macdonald S. Non–response bias in alcohol and drug population surveys, *Drug Alcohol Rev* 2009;28:648–657.

25 Studer J, Baggio S, Mohler-Kuo M, et al. Examining non-response bias in substance use research: Are late respondents proxies for non-respondents? *Drug Alcohol Depend* 2013;132:316–323.

26 Furtwaengler N, de Visser R. Lack of consensus in low-risk drinking guidelines. *Drug Alcohol Rev* 2013;32:11-18.

27 Campbell CA, Hahn RA, Elder R, et al. Guide to Community Preventive Services: The Effectiveness of Limiting Alcohol Outlet Density as a Means of Reducing Excessive Alcohol Consumption and Alcohol-Related Harms. *Am J Prev Med* 2009;6:556-569.

28 Popova S, Giesbrecht N, Bekmuradov D, et al. Hours and days of sale and density of alcohol outlets: Impacts on alcohol consumption and damage: A systematic review. *Alcohol Alcohol* 2009;44(5):500-16.

29 Berke EM, Tanski SE, Demidenko E, et al. Alcohol Retail Density and Demographic Predictors of Health Disparities: A Geographic Analysis. *Am J Public Health* 2010;100(10):1967-71.

30 Romley JA, Cohen D, Ringel J, et al. Alcohol and environmental justice: the density of liquor stores and bars in urban neighborhoods in the United States. *J Stud Alcohol* 2007;68(1):48-55.

31 Costa-Font J, Hernandez-Quevedo C, Jimenez-Rubio D. Income inequalities in unhealthy lifestyles in England and Spain. *Econ Hum Biol* 2014;16:66-75.

32 van Kippersluis H, Galama TJ. Why the Rich drink more but smoke less: The Impact of Wealth on Health Behaviors. Tinbergen Institute Discussion Papers 13-035/V, Tinbergen Institute. 2013.

33 Com-Ruelle L, Dourgnon P, Jusot F, et al. Les problèmes d'alcool en France: quelles sont les populations à risque ? *IRDES Question d'Économie de la Santé* 129. 2008.

34 Rogers EM, Shoemaker FF. Communication of innovations: A cross-cultural approach. New York: Free Press. 1971.

35 Kuntsche S, Gmel G. The smoking epidemic in Switzerland – an empirical examination of the theory of diffusion of innovations. *Soz Präventivmed* 2005;50:344–354.

36 Grittner U, Kuntsche S, Gmel G, et al. Alcohol consumption and social inequality at the individual and country levels - results from an international study. *Eur J Pub Health* 2013;23(2):332-9.

37 Shield K, Rehm J. Difficulties with telephone-based surveys on alcohol consumption in high-income countries: the Canadian example, *Int J Methods Psychiatr Res* 2012;21(1):17-28.

38 Ludbrook A, Petrie D, McKenzie L, et al. Tackling alcohol misuse: purchasing patterns affected by minimum pricing for alcohol. *Appl Health Econ Health Policy* 2012;10(1):51-63.

ANNEXES

Annex 1 -Methods

Data description

Ethnicity is reported in England, New Zealand, and the US. Marital status is classified into Married /Single /Other. Working status is defined as Working /Not working. Smoking is categorised into Current /Ex- /Never smoker. International standard classifications, such as ISCED for education and ISCO for occupation, were used to deal with the data heterogeneity issue. Education level is recoded into three groups: low (ISCED 0, 1, 2) / medium (3, 4) / high (5, 6). An attempt was made to standardise different occupation-based SES, by recoding occupations as: lowest (unskilled manual) / middle-low (semi-skilled manual) / middle (skilled manual, non-manual) / middle-high (managerial technical) / highest (professional). Five-level occupation-based SES variable was available or could be derived in England, France, Hungary, Japan, Spain, and Switzerland. In countries for which an occupation-based SES variable could not be derived, household income was instead used as an indicator of SES. These include Canada, Finland, Germany, Ireland, Korea, New Zealand, and the USA. Data description and comparability are available on demand.

Measuring between-country disparities

The concentration index (CI) assesses the correlation between the individual's hazardous drinking status and the individual's ranking in the distribution of education level (and SES, respectively). Since the studied outcome "hazardous drinking" is a negative health outcome, the education (and SES) ladder is ranked from the highest to the lowest level, in order to facilitate the interpretation of the index. The CI of a health variable Y is computed using the simple convenient covariance formula (O'Donnell, Van Doorslaer, Wagstaff, & Lindelow, 2008):

$$\mathrm{CI} = \frac{2 \times \mathrm{cov}_{\mathrm{w}}(\mathrm{yi}\,, \mathrm{Ri})}{\mu}$$

where μ is the weighted sample mean of Y, cov_w denotes the weighted covariance and R_i is the relative fractional rank of the i^{th} individual in the education level distribution. The standard errors computed for

the CI are robust to heteroskedasticity and autocorrelation (Kakwani, Wagstaff, & Van Doorslaer, 1997). For binary health outcomes, the bounds of the CI depend on the minimum, the maximum and the mean of the health variable. This is potentially problematic for international comparisons when the prevalence of the health outcome varies across countries. To take account of this issue, Wagstaff (2005) and Erreygers (2009) proposed modified versions of the CI for binary outcomes. We present in this paper the Wagstaff's index defined as:

$\mathrm{WCI} = \frac{\mathrm{CI}}{(1-\mu)}$ where μ is the weighted mean of the health outcome.

The WCI is bounded between -1 and 1, with the sign indicating the direction of inequality -a positive index indicates that people with less education or lower SES are more likely to be hazardous drinkers, a zero value indicates no inequality, and a negative index indicates that people with more education or higher SES are more likely to be hazardous drinkers. It is worth noting that when zero inequality occurs, it may hide that, for example, inequality favouring the worst-off in one part of the distribution exactly offsets inequality favouring the best-off in another. The concentration index and its standard error are computed with the Stata concindc command for the micro-data with a categorical welfare variable (Chen, 2007).

Correcting for self-reported alcohol consumption

The corrected mean (μ_i) and standard deviation (σ_i) of the shifted distribution are defined as follows:

$\mu_i = \frac{m_i}{r}$ where m_i is the weighted sample mean in group *i* and *r* the coverage rate.

$\sigma_i = \mu_i * 1.171$ for men and $\sigma_i = \mu_i * 1.258$ for women, where the multiplicative constants are empirically derived from international data (Kehoe, Gmel, Shield, Gmel, & Rehm, 2012).

This approach assumes that the shifted alcohol distribution for each gender and age group *i* has a gamma form with the scale (α) and shape (β) parameters as follows: $\alpha_i = \frac{\sigma_i^2}{\mu_i}$ and $\beta_i = \frac{\mu_i^2}{\sigma_i^2}$

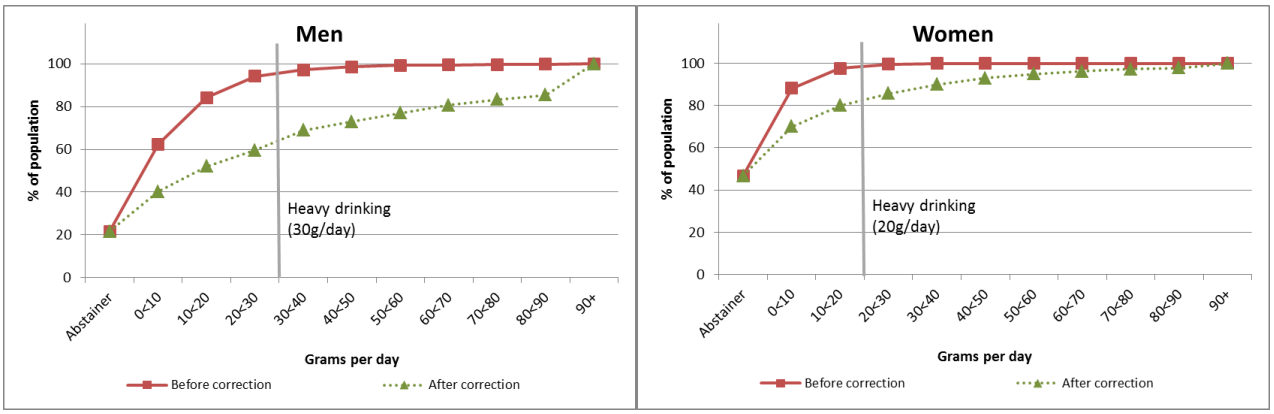
Each individual (abstainers excluded) is assigned a new upshifted alcohol consumption amount on the basis of his/her percentile position in the original distribution. Weighted percentile rank is calculated for each individual in the original distribution. If two or more individuals have the same amount of alcohol,

they are attributed the same percentile rank. Once the correction is applied, individuals are assigned a new corrected HD status. We then compute the new WCI after correction.

As a result of the correction, the cumulative distribution of alcohol consumption is shifted to the right, indicating higher levels of consumption (see Figure A1). After correction, the quantity of alcohol drunk per week increases to various extent by level of drinking: by 26g in mild[17] drinkers, 188g in moderate drinkers, and 760g in hazardous drinkers in men (respectively, 16g, 109g and 387g in women) on average in all countries. The size of the correction is by construction larger for the heaviest drinkers, this assumption being supported by previous findings showing larger self-report bias in heavy drinkers (Townshend & Dukat, 2002; Lemmens, Knibbe, & Tan, 1988; Zhao, Stockwell, & Macdonald, 2009; Studer, *et al.,* 2013).

Figure A1. Cumulative distribution of alcohol grams per day

before and after correction, men and women



References

Chen, ZA. 2007. CONCINDC: Stata module to calculate concentration index with both individual and grouped data. Statistical Software Components S456802, Boston College Department of Economics.

Erreygers, G. (2009). Correcting the Concentration Index. *J Health Econ* 28:504-515.

[17] Mild drinkers correspond to those having one or less drink per week.

Kakwani, N.C., Wagstaff, A., & Van Doorslaer, E. (1997). Socioeconomic inequalities in health: Measurement, computation and statistical inference. *Journal of Econometrics*, 77(1):87-104.

Kehoe, T., Gmel, G., Shield, KD., Gmel, G, & Rehm, J. (2012). Determining the best population-level alcohol consumption model and its impact on estimates of alcohol-attributable harms. Population Health Metrics, 10:6.

Lemmens P, Knibbe RA, Tan F. Weekly recall and diary estimates of alcohol consumption in a general population survey. *J Stud Alcohol* 1988;49:131–135.

O'Donnell, O., Van Doorslaer, E., Wagstaff, A., & Lindelow, **A**. (2008). Analyzing Health Equity Using Household Survey Data. The World Bank, Washington D.C.

Studer J, Baggio S, Mohler-Kuo M, et al. Examining non-response bias in substance use research: Are late respondents proxies for non-respondents? *Drug Alcohol Depend* 2013;132:316–323.

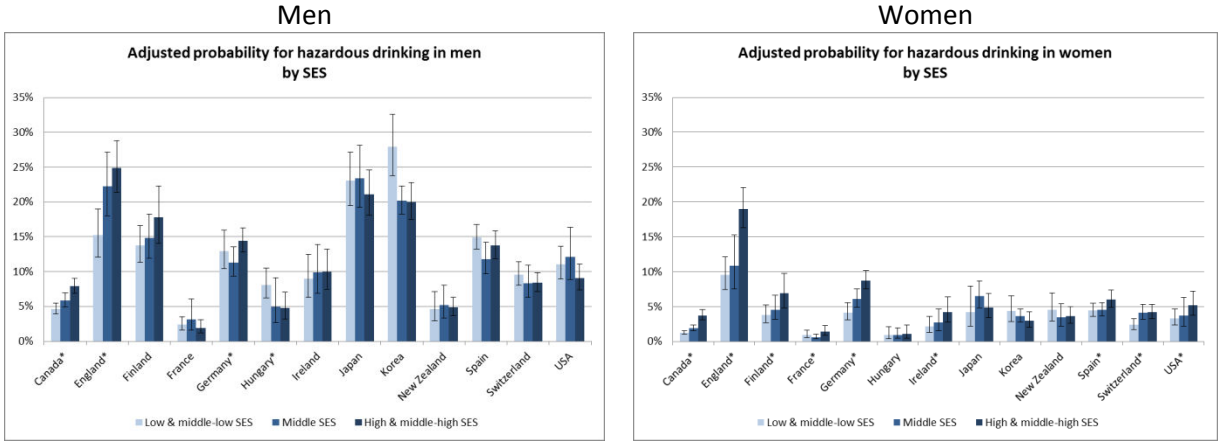
Townshend JM, Dukat T. Patterns of alcohol drinking in a population of young social drinkers: a comparison of questionnaire and diary measures. *Alcohol Alcohol* 2002;37(2):187-92.

Wagstaff, A. (2005). The bounds of the concentration index when the variable of interest is binary, with an application to immunization inequality. *Health Economics,* 14:429-432.

Zhao J, Stockwell T, Macdonald S. Non–response bias in alcohol and drug population surveys, *Drug Alcohol Rev* 2009;28:648–657.

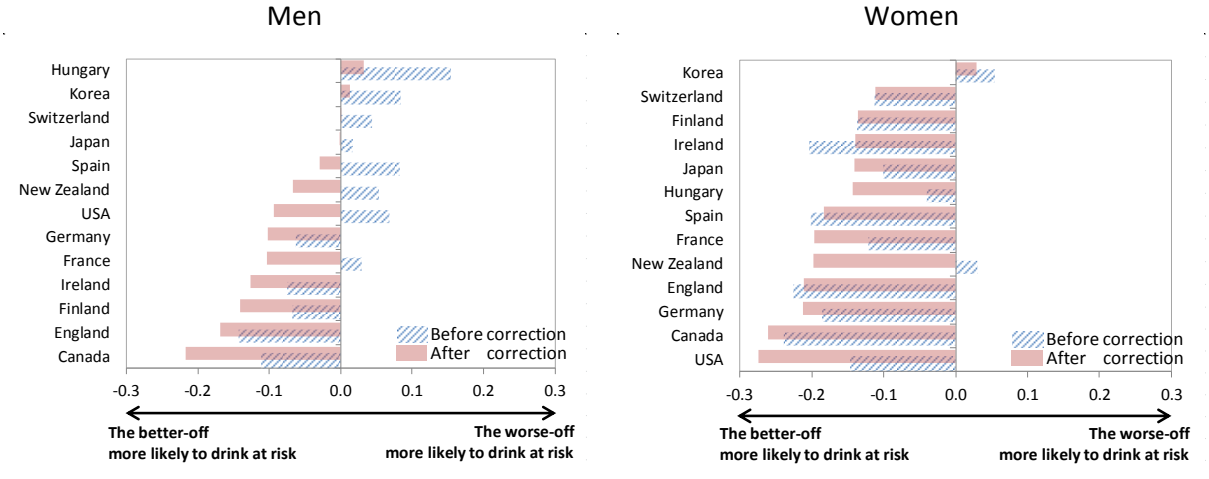
ANNEX 2- Social Disparities in Hazardous Alcohol Use: Self-report Bias May Lead to Incorrect Estimates

Figure B1. Adjusted probabilities of hazardous drinking by socioeconomic status (SES), men and women



Source: Authors' estimates based on national health survey data.
Note: * means that the overall gradient is significant at 5%.

Figure B2. WCIs for hazardous drinking by SES, before and after correcting for self-report bias, men and women



Source: Authors' estimates based on national health survey data.

Table B1. WCIs for hazardous drinking, before and after correction, by education level and by SES

	Before correction		After correction		Difference in WCI	Before correction		After correction		Difference in WCI
	WCI by education	*S.E*	WCI by education	*S.E*		WCI by SES	*S.E*	WCI by SES	*S.E*	
Men										
Canada	-0.014	*0.001*	-0.120	*0.001*	-0.106	-0.111	*0.001*	-0.218	*0.001*	-0.107
England	-0.095	*0.002*	-0.115	*0.003*	-0.019	-0.143	*0.002*	-0.169	*0.002*	-0.026
Finland	-0.030	*0.002*	-0.068	*0.002*	-0.038	-0.068	*0.002*	-0.141	*0.002*	-0.073
France	0.002	*0.002*	-0.070	*0.001*	-0.072	0.030	*0.002*	-0.104	*0.001*	-0.133
Germany	-0.079	*0.001*	-0.091	*0.001*	-0.013	-0.063	*0.002*	-0.102	*0.001*	-0.039
Hungary	0.074	*0.004*	-0.021	*0.002*	-0.095	0.155	*0.003*	0.033	*0.002*	-0.122
Ireland	0.041	*0.002*	-0.073	*0.002*	-0.114	-0.074	*0.002*	-0.127	*0.002*	-0.052
New Zealand	0.069	*0.002*	0.020	*0.001*	-0.049	0.053	*0.002*	-0.068	*0.001*	-0.121
Switzerland	0.041	*0.001*	-0.006	*0.001*	-0.048	0.044	*0.001*	0.001	*0.000*	-0.043
USA	0.101	*0.001*	-0.089	*0.001*	-0.190	0.069	*0.001*	-0.094	*0.001*	-0.163
Spain	0.072	*0.001*	-0.031	*0.000*	-0.103	0.083	*0.001*	-0.029	*0.001*	-0.113
Korea	0.171	*0.001*	0.086	*0.001*	-0.085	0.085	*0.002*	0.013	*0.001*	-0.072
Japan	0.049	*0.002*	0.044	*0.002*	-0.005	0.017	*0.002*	-0.001	*0.002*	-0.017
Women										
Canada	-0.119	*0.002*	-0.172	*0.002*	-0.053	-0.239	*0.001*	-0.261	*0.001*	-0.022
England	-0.219	*0.003*	-0.209	*0.003*	0.009	-0.226	*0.003*	-0.212	*0.003*	0.014
Finland	-0.148	*0.002*	-0.087	*0.002*	0.061	-0.138	*0.004*	-0.136	*0.002*	0.002
France	-0.162	*0.003*	-0.202	*0.001*	-0.040	-0.122	*0.004*	-0.196	*0.002*	-0.074
Germany	-0.143	*0.002*	-0.140	*0.002*	0.003	-0.187	*0.002*	-0.213	*0.002*	-0.026
Hungary	-0.131	*0.003*	-0.207	*0.003*	-0.076	-0.041	*0.004*	-0.143	*0.004*	-0.102
Ireland	-0.119	*0.003*	-0.102	*0.002*	0.017	-0.204	*0.002*	-0.140	*0.002*	0.064
New Zealand	0.059	*0.001*	-0.113	*0.002*	-0.172	0.030	*0.001*	-0.198	*0.001*	-0.228
Switzerland	-0.099	*0.002*	-0.104	*0.002*	-0.006	-0.114	*0.002*	-0.112	*0.002*	0.002
USA	-0.036	*0.002*	-0.172	*0.004*	-0.136	-0.148	*0.001*	-0.275	*0.002*	-0.127
Spain	-0.126	*0.002*	-0.148	*0.001*	-0.022	-0.202	*0.001*	-0.183	*0.001*	0.019
Korea	0.102	*0.002*	0.082	*0.002*	-0.020	0.054	*0.002*	0.029	*0.001*	-0.025
Japan	-0.035	*0.004*	-0.081	*0.004*	-0.046	-0.101	*0.004*	-0.141	*0.004*	-0.040

Source: Authors' estimates based on national health survey data.

Chapter 4.

Income-related inequalities and inequities in health care services utilisation in 18 selected OECD countries

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ABSTRACT

A key policy objective in OECD countries is to achieve adequate access to health care for all people on the basis of need. Previous studies have shown that there are inequities in health care services utilisation (HCSU) in the OECD area. In recent years, measures have been taken to enhance health care access.

This paper re-examines income-related inequities in doctor visits among 18 selected OECD countries, updating previous results for 12 countries with 2006-2009 data, and including six new countries. Inequalities in preventive care services are also considered for the first time. The indirect standardisation procedure is used to estimate the need-adjusted HCSU and concentration indexes are derived to gauge inequalities and inequities.

Overall, inequities in HCSU remain present in OECD countries. In most countries, for the same health care needs, people with higher incomes are more likely to consult a doctor than those with lower incomes. Pro-rich inequalities in dental visits and cancer screening uptake are also found in nearly all countries, although the magnitude of these varies among countries. These findings suggest that further monitoring of inequalities is essential in order to assess whether country policy objectives are achieved on a regular basis.

1. INTRODUCTION

Most OECD countries have endorsed as major policy objectives the reduction of inequalities in health status and the principle of adequate or equal access to health care based on need. Equity of access is a key element of health system performance in OECD countries [1, 2].

Effective health care coverage provides financial security against expenses due to unexpected or serious illness, and promotes access to medical goods and services. Most OECD countries have achieved universal, or near-universal coverage of their populations for a core set of health care services. Access to doctor services is ensured at relatively low or no cost for patients. Other services such as dental care and pharmaceutical drugs are often partially covered, although there are a number of countries where coverage for these services must be purchased separately [3]. Preventive screening services for certain cancers such as breast and cervical cancer are generally also available at little or no cost. However, despite these health system features, the utilisation of health care services has been shown to be unevenly distributed across population groups [4-11].

There is already a substantial body of evidence for many countries that inequities -*i.e. inequalities remaining after adjusting for needs for health care*- exist in the use of certain health care services. Previous research on OECD countries in the early 2000s showed that the better-off were more likely to see a medical specialist, and they often visited these specialists more frequently [4, 5]. Dental care was also used more often by the better-off whereas the picture for general practitioner (GP) visits was less clear-cut with some evidence for pro-poor inequities. Likewise, European studies using data around the year 2000 confirmed these patterns [6, 7]. Since that time, several countries have introduced policy measures. In particular, one can think of the introduction of a free complementary health insurance coverage for low-income people (called CMU-C) in France in 2000, the extension of public-funded dental care coverage to the whole population in Finland in 2002, the increase in GPs supply in deprived areas in England after 2002, the introduction of gatekeeping in Germany in 2004, or the recent implementation of public screening programmes in a number of OECD countries. These new features may have modified access to care and thus it is of interest to re-examine inequalities in health care services utilisation (HCSU) to assess the effectiveness of policy outcomes.

Moreover, although an increasing number of studies pay attention to inequalities in the use of preventive care in the international context [8, 9], to our knowledge, only two studies have focused on gauging these inequalities. The first one covers income-related inequalities in cervical cancer screening in 67 countries (mainly developing countries) [10], and the second one measures inequalities in preventive care treatment in European countries [11]. Our study contributes to this research focusing on both breast and cervical cancer screening and covering a broader set of countries.

This paper aims to re-examine income-related inequalities and inequities in HCSU in 18 OECD countries with 2006-2009 data. It updates previous results for 12 countries from the van Doorslaer and Masseria study [5], and covers six new countries (including New Zealand and five Eastern European countries). The range of health care services includes doctor and dentist visits, and is extended to breast and cervical cancer screening.

This paper contains four sections. After the preceding Introduction, Section 2 describes the data and methods used to measure income-related inequalities and inequities in HCSU. Section 3 presents results among 18 OECD countries. Section 4 provides a discussion of findings and concludes the paper.

2. DATA AND METHODS

Data on HCSU were taken from national health surveys of 18 selected OECD countries. For most European countries, these came from the European Health Interview Survey (EHIS), which was implemented across countries between 2006 and 2009. For other countries, the most recent national health surveys were used (see Table 1). Although the use of different national surveys for several years might be a source of data heterogeneity across countries, all the variables were constructed in order to get the highest level of comparability.

Table 1. List of survey data

Country	Survey data	Population counts	Probability of visiting at least once in the past 12 months					
			Doctor	GP	Specialist	Dentist	Breast cancer screening (in the past 2 years)	Cervical cancer screening (in the past 3 years)
Austria	Österreichische Gesundheitsbefragung 2006/07 (EHIS)	14,951	n.a.	0.79	n.a.	0.61	0.80	0.82
Belgium	Belgium Health Survey 2008 (EHIS)	4,392	0.86	0.82	0.51	0.58	0.74	0.71
Canada	Canadian Community Health Survey 2007/08	101,127	0.86	0.77	0.56	0.65	0.74	0.78
Czech Republic	European Health Interview Survey in the Czech Republic 2008 (EHIS)	1,452	0.84	0.73	0.58	0.71	0.67	0.68
Estonia	Estonian Health Interview Survey 2006/07 (EHIS)	5,833	0.74	0.67	0.47	0.48	0.36	0.30
Finland	Welfare and services Survey (HYPA -survey) 2009	3,916	0.69	0.58	0.40	0.59	n.a.	n.a.
France	Enquête Santé Protection Sociale 2008	10,174	0.91	0.86	0.57	0.75(a)	0.77	0.73
Germany	German Telephone Health Interview Survey (GEDA) 2009	19,765	0.88	n.a.	n.a.	n.a.	n.a.	n.a.
Hungary	European Health Interview Survey 2009 (EHIS)	4,508	0.84	0.76	0.60	0.37	0.65	0.63
Ireland	Survey of Lifestyle, Attitudes and Nutrition in Ireland 2007	8,569	n.a.	0.74	n.a.	0.52	0.33(b)	0.16(b)
New Zealand	National Health Survey 2006-07	10,629	0.82	0.80	0.33	0.51	0.76	0.74
Poland	Europejskie Ankietowe Badanie Zdrowia 2009 (EHIS)	23,181	0.77	0.71	0.48	0.42	0.59	0.72
Slovak Republic	Európsky prieskum zdravia 2009 (EHIS)	4,113	0.83	0.77	0.55	0.69	0.58	0.61
Slovenia	Anketa o zdravju in zdravstvenem varstvu 2007 (EHIS)	1,528	0.77	0.71	0.46	0.56	0.50	0.78
Spain	Encuesta Europea de Salud 2009	17,253	0.83	0.77	0.53	0.45	0.85	0.79
Switzerland	Swiss Health Survey 2007	14,491	0.79	0.66	0.52	0.65	0.52	0.34
United Kingdom	British Household Panel Survey 2009	11,949	0.79	0.76	0.42	0.69	0.52	0.50
United States	Medical Expenditure Panel Survey 2008	22,611	0.68	n.a.	n.a.	0.42	0.78	0.85

Note: n.a. means not available. (a) Visits in the past 24 months; (b) Visits in the past 12 months

2.1. HCSU variables

Three types of health care services were analysed, these being: (i) doctor visits (separate GP and specialist); (ii) dentist visits; and (iii) breast and cervical cancer screening services for women. The probability of having a medical visit at least once in the past 12 months is measured for contacts with a doctor and a dentist in all countries (with the exception of dental visits in the past 24 months in France).

National guidelines relating to cancer screening may differ across countries, affecting the inclusion age and frequency of visit. To perform international comparisons, the same age range and frequency were adopted as those used by international research groups [12, 13]. For breast cancer screening, the focus was on women aged 50-69 years who reported having a mammogram in the past 2 years, and for cervical cancer screening, women aged 20-69 years who had a Pap smear test in the past 3 years. The recall period for cancer screening in Ireland referred to the past 12 months.

Table 1 provides the survey name, the sample size, and the probability of HCSU in the 18 countries studied. Further information on the variables of interest is displayed in the web appendix Table A1.

2.2. Need-adjustment

Persons in lower socioeconomic groups have higher rates of morbidity, and have greater needs for health care [3, 14]. Doctor, GP and specialist visits are thus adjusted to remove the effect of differing needs for care among persons with different income levels, so that the horizontal equity principle can be tested, as this was previously applied [4, 5].

Let Y be the HCSU and X a set of health care need variables. The indirect standardisation procedure as described in O'Donnell *et al.* [15], is used to estimate the need-adjusted HCSU, Y^{IS}.

$$Y_i^{IS} = Y_i - Y_i^X + Y_{mean}$$

where is Y^X_i, is the need-predicted utilisation and Y_{mean} the sample mean.

The need-predicted HCSU, Y^X_i, *i.e. the expected utilisation if all individuals used health care services on the basis of their needs*, is predicted for each individual i by regressing the actual utilisation Y_i on a set of need variables on one hand, and non-need variables which are fixed at the sample mean on the other hand. A logit link function is used for the regression model. The need variables correspond to a range of indicators

including age, gender, self-assessed health and limitations in daily activities. Controlling for a range of socio-demographic non-need variables permits to accurately estimate the need-HCSU relationship. We follow Van Doorslaer *et al.* [4, 5] and control for ethnicity, education level, marital status and private insurance status[18] -that may affect the efficiency of health production and the propensity to seek care-, and for activity status, region and level of urbanisation -that may affect time price of HCSU. A description of the variables used for the need-adjustment procedure is provided in the web appendix Table A1.

This study also assesses income-related inequalities in dentist visits and breast and cervical cancer screening uptake, however the need-adjustment is not performed for two reasons. First, an annual dental visit being recommended for all persons in most countries, and cancer screening being recommended for women in the targeted age group, one can assume equal needs for preventive care. Second, most data sources do not systematically provide information on needs for curative dental care, that technically prevents from adjusting for needs.

2.3. Income

Equivalised household income is used as the ranking variable. Data correspond to household total income from all sources after tax and deductions, except in New Zealand and the United Kingdom where income is before tax. Effort is made to equivalise household income with the OECD modified scale in order to account for differences in household's size and composition, though the equivalisation procedure somewhat differs across countries due to data limitations. For countries where income is a continuous variable, the equivalised household income is consistently derived (Finland, France, Germany, Spain, Switzerland, UK, and USA). For countries where household income is categorised into brackets or deciles, two approaches are used. If the income brackets mid-points are available, the equivalised income is derived using the mid-point value and the size of the household (Ireland and New Zealand). If not, the equivalised income is derived by crossing data from income categories and the size of the household (Canada and EHIS countries)[19].

[18] Although the inclusion of private health insurance in the specification of the model may create an endogeneity problem due to selection effect, a sensitivity analysis showed that the findings were robust. We replicated the analysis without including insurance and found that the overall results for the measure of inequities were unchanged.

[19] Detail on the construction of equivalised income in Canada and EHIS countries is available on demand.

2.4. Measuring inequalities

The concentration index (CI) is used to quantify the degree of inequality of actual medical care utilisation related to income level by assessing the correlation between the individual's HCSU and the individual's ranking in the income distribution. The CI of a health variable Y can be computed using the simple convenient covariance formula [15]:

$$CI = \frac{2 \times cov_w(yi\ , Ri)}{\mu}$$

where μ is the weighted sample mean of Y, cov_w denotes the weighted covariance and R_i is the relative fractional rank of the *i*th individual in the income distribution. The standard errors computed for the CI are robust to heteroskedasticity and autocorrelation [16]. The CI permits to gauge relative inequalities *i.e.* a positive index indicates pro-rich inequality, a negative index pro-poor inequality, and a zero value no inequality. The more the HCSU is concentrated on the most advantaged (most disadvantaged) groups, the higher (lower) is the value of the CI. If HCSU is equally distributed among socioeconomic groups, then the CI is equal to zero.

However, for binary health outcomes, the bounds of the CI depend on the minimum, the maximum and the mean of the health variable. This is potentially problematic for international comparisons when the prevalence of the health outcome varies across countries. To take account of this issue, Wagstaff (2005) and Erreygers (2009) proposed a corrected version of the CI for binary outcomes [17, 18]. We present in this paper the Wagstaff's index defined as:

$$W = \frac{CI}{(1-\mu)}$$

where μ is the weighted mean of the health outcome[20]. All analyses use sampling weights.

This paper deals with the two concepts of inequalities and inequities in HCSU as defined above. In the following sections, the term 'inequity' refers to inequality for need-adjusted HCSU –*i.e.* for doctor, GP and specialist visits- whereas the term 'inequality' is employed for dentist visits and cancer screening uptake, not adjusted for health care needs.

[20] The analysis was also carried out with the Erreygers index. Results were broadly similar.

2.5. National health system characteristics

The 18 countries studied in this analysis have different health system characteristics that may affect inequalities and inequities in HCSU. At the time of the data collection -around 2006-2009- most of these countries have achieved universal health coverage for their population except USA. The share of public and private health financing (including private insurance and out-of-pocket payment) varies across countries, with a large share of private financing in Hungary, Switzerland, and USA. The share of out-of-pocket payments as percentage of expenditure in dental care measures the financial burden for households; it shows variations from 42% in Germany to 98% in Spain. Cost-sharing arrangements for doctor's visits -like free care at the point of delivery in Austria, Canada, Germany, Poland, Spain and UK- are likely to influence equity in access to health care. Countries with strengthened primary care organisation and gatekeeping system may provide simpler access and better guidance for people in lower socio-economic positions.

Table 2. Health system features

Country	Primary health coverage (% of population), 2009	Public expenditure (% of TCHE), 2009	Private insurance expenditure (% of TCHE), 2009	Private households out-of-pocket expenditure (% of TCHE), 2009	Private expenditure (% total dental care expenditure), 2009	Cost-sharing arragements, 2012	Primary care physician registration, 2008	Referral to access to specialist care, 2008	Type of provision of care, 2008	Breast cancer screening programme, 2010	Cervical cancer screening programme, 2010
Austria	99	77.2	4.6	17.0	50.3	Mostly free at the point of use for contracted physicians	Not required	Not required	Mostly private	N.A.	N.A.
Belgium	99.5	76.0	4.1	19.6	45.7	Per-visit co-payments for outpatient care	Not required	Not required	Mostly private	Nationwide population-based, Free access	Non-population-based
Canada	100	70.3	13.2	15.0	94.6	Free at the point of care	Not required	Required	Mostly private	Population-based but not nationwide, Access with fee	Population-based but not nationwide
Czech Republic	100	83.4	0.2	14.9	49.7	Per-visit co-payments for outpatient care	Not required	Not required	Mostly private	Nationwide population-based, Free access	Nationwide population-based, Free access
Estonia	93.7	78.1	0.2	21.2	51.3	N.A.	Required	Required	Mostly private	N.A.	Nationwide population based, N.A.
Finland	100	74.8	2.2	19.5	55.7	Per-visit co-payments for outpatient care	Not required	Required	Mixed	Nationwide population-based, Free access	Nationwide population-based, Free access
France	99.9	77.6	14.0	7.7	63.9	Per-visit co-payments for outpatient care	Not required	Not required	Mostly private	Nationwide population-based, Free access	Population-based but not nationwide, Access with fee
Germany	100	77.2	9.6	12.3	42.1	Free at the point of care	Not required	Not required	Mostly private	Nationwide population-based, Free access	Nationwide population based (since 2013), Free access
Hungary	100	65.5	2.7	25.9	65.1	Per-visit co-payments for outpatient care	Not required	Required	Mixed	Nationwide population-based, Access with fee	Nationwide population-based, Free access
Ireland	100	75.0	N.A.	N.A.	N.A.	Free for medical card holders (40% of pop) and full cost for non-medical card holders.	Not required	Not required	Mixed	Nationwide population-based, Free access	Nationwide population-based, Free access
New Zealand	100	83.0	5.0	10.6	65.7	Cost-sharing for outpatient primary care, no cost-sharing for specialist care	Not required	Required	Mixed	Nationwide population-based, Free access	Nationwide population-based, Free access
Poland	97.6	71.7	0.6	24.4	64.0	Free at the point of care	Not required	Required	Mostly private	Nationwide population-based, Free access	Nationwide population-based, Free access
Slovak Republic	95.2	69.2	0.0	26.9	55.3	N.A.	Required	Required	Mostly private	Non population-based, Free access	Non-population-based, Free access
Slovenia	100	72.9	13.5	12.7	49.2	Cost-sharing	Required	Required	Mixed	Population-based but not nationwide, Access with fee	Nationwide population-based, Free access
Spain	99.2	74.3	5.9	19.5	98.5	Free at the point of care	Required	Required	Mostly public	Nationwide population-based, Free access	Population-based but not nationwide, Access with fee
Switzerland	100	65.5	8.8	24.7	93.3	Cost-sharing after general deductible	Not required	Not required	Mostly private	Population-based but not nationwide, Free access	Non-population-based, Free access
United Kingdom	100	84.1	N.A.	N.A.	N.A.	Free at the point of care	Not required	Required	Mixed	Nationwide population-based, Free access	Nationwide population-based, Free access
USA	81.3	47.7	35.5	12.5	90.8	N.A.	Required	Required	Mostly private	Non population-based, Access with fee	Non-population-based, Free access

Note: N.A. not available. The total current health expenditure (TCHE) comprises public expenditure, private insurance, household out-of-pocket as well as non-profit institutions serving households and corporations (other than health insurance).

Source: OECD Health Statistics 2013 [13]; Author's information based on OECD Health System Characteristics surveys 2008 and 2012 [19]; OECD, 2013 [20]

The gatekeeping system is in place in Estonia, Slovak Republic, Slovenia, Spain and USA, through a compulsory registration to a primary care physician and a required referral to access specialist care. Organisational features such as the type of health care provision –mostly private in 11 countries- and the existence of public screening programmes may also play a role on access to care. Free nationwide population-based screening mammography programmes operate in 2010 in Belgium, Czech Republic, Finland, France, Germany, Ireland, New Zealand, Poland, Spain, and UK (not nationwide in most of other countries). Pap smear tests are available through free nationwide population-based programmes in Czech Republic, Finland, Germany, Hungary, Ireland, New Zealand, Poland, Slovenia, and UK[21]. Data on health system characteristics presented in Table 2 refer to the years 2008 to 2012 and come from OECD data sources [13, 19, 20]. We refer to these cross-country differences when interpreting the study findings.

3. RESULTS

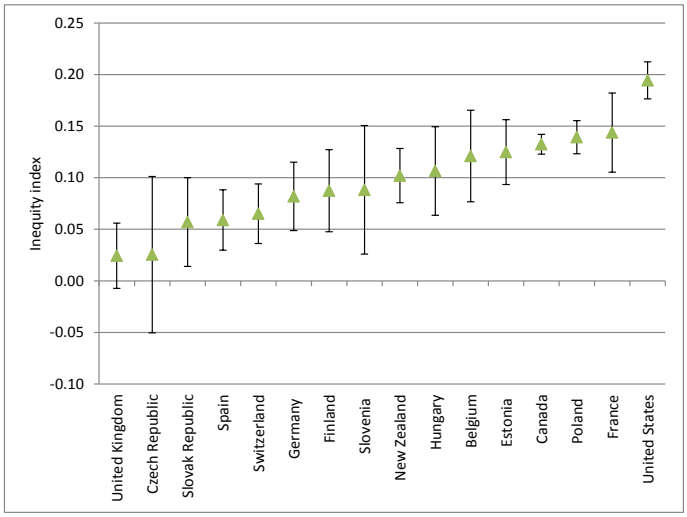
3.1. Inequities in need-adjusted doctor visits

Figure 1 shows income-related inequities in the probability of a doctor visit after adjusting for individuals' needs for health care. The inequity index is significantly greater than zero in 14 out of 16 countries, indicating that for the same level of needs for health care, people with higher incomes are significantly more likely to visit a doctor than those with lower incomes. The magnitude of these inequities varies among countries, USA displaying the largest inequities followed by France, Poland, and Canada. In contrast, Slovak Republic, Spain and Switzerland show a lower degree of inequities. At the other end of the spectrum, UK presents an inequity index which is not statistically different from zero, indicating that no inequities can be detected. This is also the case for Czech Republic although the small sample size in Czech Republic limits the ability to detect significant effects. The degree of inequity is the highest in USA, where the universal health primary coverage was not achieved. Beyond primary coverage, the role of private health insurance is of importance. USA, France, and Canada which present large inequities, are characterised by large share of private insurance expenditure (as shown in Table 2). Larger inequities are found in countries where the provision of care is predominantly private (USA, France, Poland, Canada, Estonia, and Belgium) although this is also true in Czech and Slovak Republics, Switzerland and Germany. Virtually no

[21] Only in England, Scotland, and Wales.

inequity is found in UK where outpatient primary and specialist care is free of charge at the point of delivery. Similar settings are in place in Spain and Germany[22] where inequalities are small, but also, in Canada and Poland where inequities are larger, suggesting that other features may influence inequities in doctor visits.

Figure 1. Inequity index for the need-adjusted probability of a doctor visit and its 95% confidence intervals

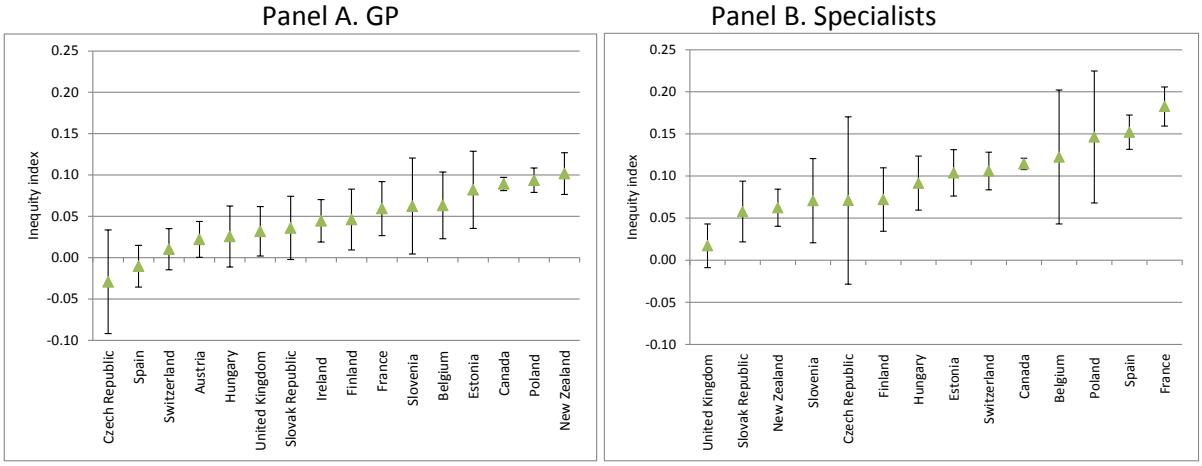


3.2. Inequities in need-adjusted GP and specialist visits

Figure 2 presents income-related inequities in GP and specialist visits after adjusting for individuals' needs for health care. Nine out of 16 countries display significant inequities in GP visits (Figure 2, Panel A). The largest inequities are observed in Canada, Poland, and New Zealand. Conversely, seven countries present no significant inequities, indicating that people with lower incomes are as likely as those with higher incomes to consult a GP. Germany and USA do not present data split by GP and specialist. The largest inequities in GP visits are found in New Zealand where the average cost-sharing for an outpatient primary care physician contact is about 30%, with a range of copayments depending on practice type and patient status. In contrast, smaller inequities are observed in countries providing free care at the point of delivery (Spain, Austria, and UK) or with a small copayment of about 1 euro per visit (Czech Republic and Hungary).

[22] For people with statutory health insurance.

Figure 2. Inequity index for the need-adjusted probability of a GP visit and a specialist visit, and its 95% confidence intervals



The variation of inequities in specialist visits among countries (Figure 2 Panel B) is larger than that of inequities in GP visits, and the pattern is also clearer. In all countries -but two- the inequity index is significantly greater than zero, which means that for the same needs for health care, people with higher incomes visit specialists more often than those with lower incomes. In particular, France and Spain display the largest inequities. On the other hand, no inequities can be detected in UK (and in Czech Republic due to the small sample size) and low degrees of inequities are found in Slovak Republic, New Zealand[23], and Slovenia. These three countries as well as UK are characterised by the fact that GPs act as gatekeepers and a referral is required to get access to specialist care. However, this is also true in Spain which has the second highest degree of inequities in specialist visits. Beyond that, the distinction between public and private sectors has its importance since inequities in specialist visits in Spain were found mainly in the private sector [21].

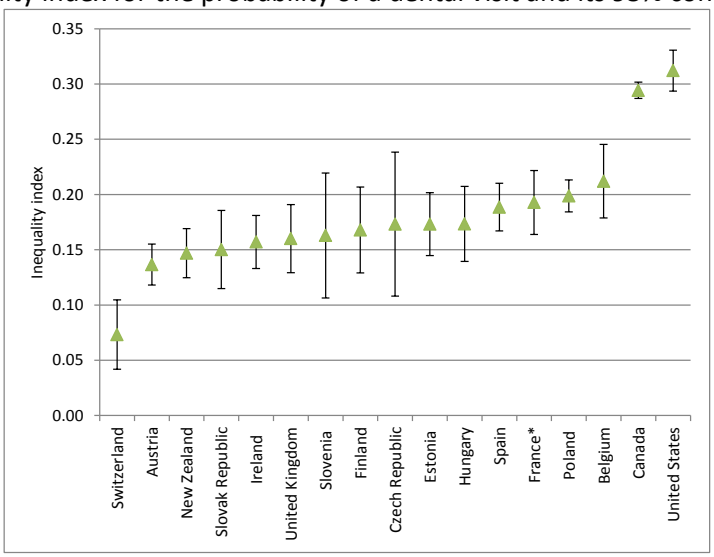
3.3. Inequalities in dentist visits

Figure 3 shows that all countries display significant income-related inequalities in dental visits. The extent of these inequalities varies greatly among countries. Canada and USA stand out with the strongest inequalities that are more than three times the degree of inequalities observed in Switzerland. The two countries with the strongest degrees of inequality are characterised by a large

[23] In New Zealand, specialist visits in contrast with GP visits are exempted from copayments

share of private expenditure for dental care (95% in Canada and 91% in USA). This is also true in Spain (99%), France (64%), and Poland (64%) where inequalities in dentist visits are large. However, Switzerland also presents a high share of private expenditure for dental care (93%) but has the lowest level of inequality. This suggests that other institutional factors play a role on inequalities in the use of dental care such as exemptions of copayments for certain groups of population.

Figure 3. Inequality index for the probability of a dental visit and its 95% confidence intervals



Note: (*) Visits in the past 24 months in France.

3.4. Inequalities in cancer screening

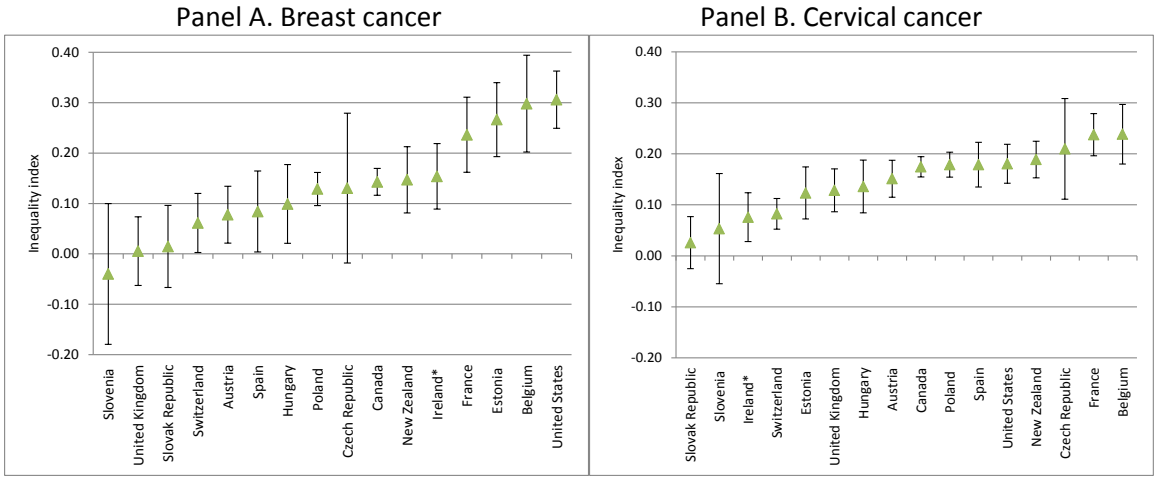
Figure 4 presents income-related inequalities in breast and cervical cancer screening (Panel A and B). Inequalities in breast cancer screening in favour of the better-off are shown in 12 out of 16 countries. The largest inequalities are observed in Belgium, Estonia, France, and USA. In contrast, no inequalities can be detected in four countries (Czech Republic[24], Slovak Republic, Slovenia, and UK). Inequalities in cervical cancer screening are shown in all countries but two. The degree of these inequalities varies from below 0.10 in Ireland, Slovak Republic, Slovenia, and Switzerland to more than 0.20 in Belgium, Czech Republic, and France.

Inequality in cancer screening must be interpreted with regards to the level of cancer screening rates (displayed in Table 1). Breast cancer screening rates are high in Austria, France, New Zealand, Spain, and USA, with more than 75% of women aged 50-69 years having a mammogram in the past 2 years. At the other end of the spectrum, in Estonia, only 36% of women had a mammogram in the past 2 years. Similarly, cervical cancer screening rates are high in USA, Austria, Spain, Slovenia, and Canada,

[24] The small sample size in Czech Republic and Slovenia prevents from detecting significant differences.

with more than 75% of women aged 20-69 years having a Pap smear test in the past 3 years, whereas this proportion is only 34% in Switzerland. The Wagstaff index used in this study already makes the adjustment for differences in the national average rate of screening, giving a higher weight to the countries with larger screening coverage. A country with a small degree of inequality and a wide screening coverage may count as much as a country with large inequalities and a small population coverage. This is the case for instance in Estonia and Belgium. Estonia has a large degree of inequality in breast cancer screening (crude CI=0.17) but a small proportion of screening uptake (36%). In comparison, Belgium has a smaller degree of inequality (crude CI=0.08) and a larger screening rate (74%). After adjustment for the level of screening rate, the Wagstaff inequality indexes are respectively 0.27 in Estonia and 0.30 in Belgium.

Figure 4. Inequality index for cancer screening and its 95% confidence intervals



Note: (*) Visits in the past 12 months in Ireland.

The utilisation of cancer screening services may largely depend on the availability of national public screening programmes. For instance, recent findings in the European region highlight that inequalities are larger in countries without a population-based screening programme [8]. In our study, the degree on inequalities in cancer screening has been examined in the light of the existence of national screening programmes, however we do not find any clear association. Beyond the existence of screening programmes, the lack of association may be related to the time since programmes were rolled out. Another explanation relies on the fact that screening is often fully covered by insurance in most countries [22, 20]. This corroborates a recent study showing that the impact of the availability of national programmes on screening uptake is mediated to a minor extent by solving financial restriction, and to a large extent by preventing women from considering screening not necessary [23].

Reasons for cancer screening uptake depend not only on national institutional features but also on individual characteristics. Ethnicity, younger age, higher education level, employment status, residential area, marital status, having health insurance, good health status, having an usual source of care and use of other preventative services, are all recognized as important additional predictors of participation in screening. For instance, in the United States, low-income women, women who are uninsured or receiving Medicaid (health insurance coverage for the poor, disabled or impoverished elderly), or women with lower educational levels report much lower use of mammography and pap smears [24]. Similarly, in European countries, significant inequalities related to education and socioeconomic status are found in the utilisation of early detection and preventive health care services [25, 26].

4. DISCUSSION AND CONCLUSIONS

Since inequities in HCSU were first assessed across OECD countries around the year 2000, governments have prioritised equity of access and made health system features evolved. This study shows that a decade later, income-related inequalities and inequities in HCSU remain existent in OECD countries. In the majority of countries, for the same needs for health care, people with higher incomes are more likely to consult a doctor –in particular, a specialist- than their counterpart with lower incomes. Inequalities in dental and preventive care are also found in most countries, if not all. The magnitude of these inequalities varies considerably among countries. Results show larger inequalities in France and USA. In particular, USA present the strongest inequalities in doctor and dentist visits. France displays the largest inequalities in specialist visits and among the largest inequalities in doctor visits and cancer screening. On the other hand, inequalities are generally smaller in Switzerland (notably in dental and preventive care) and UK (in doctor and specialist visits, and breast cancer screening).

These results are consistent with the literature [4-7]. Recent findings on European data highlight that inequities in specialist visits are the highest in France and Spain [6, 8]. Regarding dental care services, inequalities in favour of the better-off are found consistently in a large number of countries [27].

Part of cross-country discrepancies finds some explanations in the differences in health system characteristics. In particular, larger inequities are found in countries where: universal health

coverage is not achieved, health care financing relies on a large share of private insurance and out-of-pocket payments, GPs do not act as gatekeepers, health care provision is mostly private and national cost-sharing arrangement does not include free care at the point of delivery.

Comparisons with the previous study around the year 2000 [5] cannot be directly made because different types of index were employed, our study using the Wagstaff index, a more appropriate index for international comparisons. Results obtained with the exact same methodology as the one previously used (not displayed herein) suggest that overall, inequities and inequalities have remained stable over time, despite few exceptions. The country ranking and the size of inequities are reasonably consistent, especially for doctor and GP visits. Some differences in surveys and in wording of questions may affect comparisons, in particular for specialist visits in Finland and France, and for dentist visits in Ireland and Spain, but only to a less extent (detailed results available in [28]). Comparisons over time could be undertaken with more rigorous techniques like the Oaxaca-type decomposition of change in CI [29]. However, this requires to access and to harmonise survey data of several past years. This was not in the scope of this study but it could be performed in future developments.

This study offers new information on income-related inequalities in HCSU and it presents, for the first time, a cross-country comparison of the degree of inequalities in breast and cervical cancer screening. However, this paper has several limitations. First, this study could not separate public from private health care services whereas some evidence suggests that different patterns exist. Inequities in specialist visits are shown to occur largely in the private sector in Spain, while the public health system is more equitable [21]. Similarly, inequalities in dental care utilisation are found to vary between public and private services in Finland [30]. Second, this study considers dental visits as a whole since the data does not permit to distinguish curative and preventive dental care. However results may differ across both types of care, preventive dental care being associated with larger inequalities [27, 31]. A third limitation is related to the appropriateness of the definition of health care needs. In this study, health care needs include the self-assessed health status which is widely regarded as a good predictor of both health care utilisation and mortality [32, 33]. Health care needs also include objective health indicators like the limitations in daily activities. Health care needs do not include any measure of morbidity although this adjustment was shown to have its advantages [34]. Morbidity as reported in national health surveys is subject to a high heterogeneity in individual responses. For instance, people who report chronic diseases are more likely to be those with sufficient health information, being in contact with doctors, and potentially with higher incomes. The

adjustment for morbidity as reported in surveys may thus bias the measurement of socioeconomic inequalities in health [35]. Recently, methodological improvements show that assuming homogeneity in the relationship between need and use of care tends to underestimate pro-rich inequity [36]. These further improvements could be applied in future studies once the limitations of objective health measures have been handled. Last, the income variable was derived on the basis of the survey data available. A lot of effort was made to equivalise household income and to get data harmonised across countries despite differences and limitations in data sources. A sensitivity analysis for the use of income confirms the robustness of our findings. We replicated the analysis by using (not equivalised) household income and found consistent results.

This paper suggests that further monitoring of inequalities in HCSU is essential in order to assess whether country policy objectives are achieved on a regular basis. The findings highlight that inequalities and inequities in HCSU have remained present over time in the studied period in OECD countries despite developments of health care systems. However, more recent reforms are expected to lead to changes in access to care, like the extension of the primary health coverage in USA, the introduction of exemptions of copayments and up-front payments for vulnerable populations visiting GPs in Belgium in 2011, and the suppression of copayments for GP and specialist visits in Germany in January 2013. Future studies could examine the impact of these specific health reforms on equity in health care access.

REFERENCES

1 Hurst, J., Jee-Hughes, M.: Performance Measurement and Performance Management in OECD Health Systems. Labour Mark. Soc. Policy Series, Occasional Paper No 47, OECD, Paris. (2001). doi: 10.1787/788224073713

2 Kelley, E., Hurst, J.: Health care Quality Indicators Project: Conceptual Framework Paper. OECD Health Working Papers No.23. OECD Publishing, Paris. http://www.oecd.org/health/health-systems/36262363.pdf (2006). Accessed 22 June 2013.

3 OECD: Health at a Glance 2011: OECD Indicators, OECD Publishing, Paris. (2011)

4 Van Doorslaer, E., Koolman, X., Jones, A.M.: Explaining income-related inequalities in doctor utilisation in Europe. Health Econ. 13, 629–647 (2004)

5 Van Doorslaer, E., Masseria, C.: Income-related Inequality in the Use of Medical Care in 21 OECD Countries. OECD Health Working Paper No.14. OECD, Paris. http://www.oecd.org/health/health-systems/31743034.pdf (2004). Accessed 22 June 2013.

6 Or, Z., Jusot, F., Yilmaz, E.: Impact of Health care System on Socioeconomic Inequalities in Doctor Use. IRDES Working Paper No.17. IRDES, Paris. http://www.irdes.fr/EspaceAnglais/Publications/WorkingPapers/DT17ImpactHealthCareSystSocioeconomicInequalities.pdf (2008). Accessed 22 June 2013.

7 Bago d'Uva, T., Jones, A.M., van Doorslaer, E.: Measurement of Horizontal Inequity in Health care Utilisation Using European Panel Data. J. Health Econ. 28, 280-289 (2009)

8 Palència, L., Espelt, S., Rodriguez-Sanz, M., Puigpinós, R., Pons-Vigués, M., Pasarín, M.I., Spadea, T., Kunst, A.E., Borrell, C.: Socioeconomic inequalities in breast and cervical cancer screening practices in Europe: influence of the type of screening program. Int. J. Epidemiol. 39, 757-765 (2010)

9 Jusot, F., Or, Z., Sirven, N.: Variations in preventive care utilisation in Europe. Eur. J. Ageing 9, 15-25 (2012)

10 McKinnon, B., Harper, S.: Decomposing income-related inequality in cervical screening in 67 countries, Int. J. Pub. Health 56: 139–152 (2011)

11 Carrieri, V. and Wübker, A.: Assessing Inequalities in Preventive Care Use in Europe. Ruhr Economic Papers 371. http://www.rwi-essen.de/publikationen/ruhr-economic-papers/499/ (2012). Accessed 22 June 2013.

12 ECHIM European Community Health Indicators Monitoring. Accessed on 20 June 2013 : www.echim.org

13 *OECD Health Statistics*, 2013. Accessed on 05 October 2013 : http://dx.doi.org/10.1787/health-data-en

14 Mackenbach, J.P., Stirbu, I., Roskam, A.R., Schaap, M.M., Menvielle, G., Leinsalu, M., Kunst, A.E.: Socioeconomic Inequalities in Health in 22 European Countries. New England J. Med. 358, 2468-2481 (2008)

15 O'Donnell, O., van Doorslaer, E., Wagstaff, A., Lingelow, M.: Analyzing Health Equity Using Household Survey Data, The World Bank, Washington D.C. (2008)

16 Kakwani, N., Wagstaff, A., van Doorslaer, E.: Socioeconomic inequalities in health: measurement, computation, and statistical inference, J. Econom. 77, 87-103 (1997)

17 Wagstaff, A.: The bounds of the concentration index when the variable of interest is binary, with an application to immunization inequality. Health Econ. 14: 429-432 (2005)

18 Erreygers, G.: Correcting the Concentration Index. J. Health Econ. 28, 504-515 (2009)

19 Paris V., M. Devaux, L. Wei: Health Institutional Characteristics: A Survey of 29 OECD Countries, OECD Health Working Papers No. 50, OECD Publishing, Paris. http://dx.doi.org/10.1787/5kmfxfq9qbnr-en (2010). Accessed 22 Nov 2013.

20 OECD : Cancer Care: Assuring Quality To Improve Survival, OECD Publishing, Paris. (2013)

21 Regidor, E., Martínez, D., Calle, M.E., Astasio, P., Ortega, P., Domínguez, V.: Socioeconomic Patterns in the Use of Public and Private Health Services and Equity in Health care. BMC Health Serv. Res. 8, 183 (2008)

22 Schopper, D., de Wolf, C: Breast cancer screening by mammography: International evidence and the situation in Switzerland, Krebsliga Schweiz.

http://assets.krebsliga.ch/downloads/short_mammo_report_final_el_.pdf (2007). Accessed 22 June 2013.

23 Wübker, A.: Explaining variations in breast cancer screening across European countries. Eur J Health Econ (2013). doi: 10.1007/s10198-013-0490-3.

24 National Center for Health Statistics, *Health, United States, 2010: With Special Feature on Death and Dying*, NCHS, Hyattsville, MD. (2011)

25 Sirven, N., Or, Z.: Disparities in Regular Health Care Utilisation in Europe. IRDES Working Paper No. 37, IRDES, Paris. http://www.irdes.fr/EspaceAnglais/Publications/WorkingPapers/DT37DisparitiesRegularHealthCareUtilisationEurope.pdf (2010). Accessed 22 June 2013.

26 Von Wagner, C., Baio, G., Raine, R., Snowball, J., Morris, S., Atkin, W., Obichere, A., Handley, G., Rainbow, S., Smith, S., Halloran, S., Wardle, J.: Inequalities in Participation in an Organized National Colorectal Cancer Screening Programme: Results from the First 2.6 Million Invitations in England. Int. J. Epidemiol., 40, 712-718 (2011)

27 Listl, S.: Income-Related Inequalities in Dental Service Utilization by Europeans Aged 50+. J. Dental Res. 90(6), 717-723 (2011)

28 Devaux, M., M. de Looper: Income-Related Inequalities in Health Service Utilisation in 19 OECD Countries, 2008-2009, OECD Health Working Papers No. 58, OECD Publishing, Paris. http://dx.doi.org/10.1787/5k95xd6stnxt-en (2012). Accessed 22 Nov 2013.

29 Grasdal, A.L., Monstad, K.: Inequity in the use of physician services in Norway before and after introducing patient lists in primary care. International Journal for Equity in Health, 10:25, (2011)

30 Nguyen, L., Häkkinen, U.: Income-related inequality in the use of dental services in Finland. Appl Health Econ Health Policy 3(4), 251-62 (2004)

31 Grignon, M., Hurley, J., Wang, L., Allin, S.: Inequity in a Market-Based Health System: Evidence from Canada's Dental Sector. Health Policy 98, 81-90 (2010)

32 DeSalvo, K. Fan, V.S., McDonell, M.B., Fihn, S.D.: Predicting Mortality and Healthcare Utilization With a Single Question. Health Serv. Res., 40, 1234–1246 (2005)

33 Idler, E.L., Benyamini, Y.: Self-rated Health and Mortality: A Review of Twenty-seven Community Studies. J. Health Soc. Behav., 38, 21-37 (1997)

34 Bago d'Uva, T., Lindeboom, M., O'Donnell, O., and van Doorslaer, E.: Education-related inequity in healthcare with heterogeneous reporting of health. J the Royal Statistical Society: Series A Statistics in Society. 174(3), 639–664 (2011)

35 Tubeuf, S., Jusot F., Devaux M., Sermet C.: Social Heterogeneity in Self-Reported Health Status and Measurement of Inequalities in Health. IRDES Working Paper No. 12, IRDES, Paris. http://www.irdes.fr/EspaceAnglais/Publications/WorkingPapers/DT12SocialHeterogeSelfReportHealthStatus.pdf (2008). Accessed 22 June 2013.

36 Van de Poel, E., van Doorslaer, E., O'Donnell, O.: Measurement of inequity in health care with heterogeneous response of use to need. J. Health Econ. 31: 676-689 (2012).

General Conclusion

1. Summary of key findings

This thesis aims to analyse social inequalities in health-related behaviours from an international perspective. This work is composed of four chapters which relate to three inequalities-related issues: (i) addressing the challenges of measuring social inequalities in health-related behaviours using survey data for several different countries; (ii) shedding light on possible explanations of these inequalities, in particular by investigating the direction of the causal relationship, and also by examining the policy context; (iii) exploring how self-reporting may affect the measure of social inequalities. While the first chapter is an overview of data and methods, the last three chapters comprise articles that were published in economic or public health journals.

The first chapter of this thesis deals with the data and methods used in the different pieces of work presented herein. Health survey data for 23 OECD countries are described. Methodology for the measurement of social inequalities in health is presented and discussed, with a particular emphasis on the concentration index, and the absolute and relative indices.

The second chapter examines the size and the direction of the social gradient in obesity and overweight in 11 OECD countries. Education-related and SES-related disparities are measured by the means of the absolute and relative indices. Findings show that both absolute and relative inequalities need to be assessed since they may capture different dimensions and therefore lead to different country ranking. For instance, regarding education-related inequalities, absolute inequalities are largest in Hungary and Spain for both genders, whereas relative inequalities are largest in France and Sweden for men and in Spain and Korea for women. This study also shows that social inequalities in obesity and overweight are more marked in women than in men. The gender gap in social disparities in obesity is of great importance since women with low levels of education and low socioeconomic status (SES) are more likely to be obese and to give birth and raise obese children, thus perpetuating the vicious circle of social inequalities. Therefore, this paper is in support of policies aimed at targeting specific groups such as low-educated and low-SES women.

In addition to this paper, the second chapter presents an analysis that further explores the relationship between education and obesity, with the aim of understanding the nature of the link and the potential causal direction. The findings show a broadly linear relationship between the number of years of education and the probability of obesity, suggesting that increasing education at any point along that spectrum would reduce obesity to a similar degree, if the causal link between education and obesity had been established. However the causality between education and obesity

was not proven with certainty. Results from French data show that the strength of the association between education and obesity is virtually unaffected when controlling for reduced educational opportunities for those who are obese in young age, suggesting that the direction of causality runs mostly from education to obesity. Moreover, the analysis of mediation effect via the individual's socioeconomic status and the analysis of concurrent effect via education of household members show that education affect obesity essentially directly. Last, results highlight not only an absolute effect of the education level on obesity, but also a relative effect, *i.e.* the individual's education level relative to the peers' education level has an influence on obesity. In terms of policy implications, this study is in favour of further investment in education to help reduce obesity, via increased formal schooling and health education programmes, notably directed at the disadvantaged people who leave school early.

The third chapter deals with another behavioural risk factor for health: hazardous alcohol consumption. This analysis presents social disparities in hazardous drinking as reported in health surveys, and aims to assess the effect of self-report bias on social inequalities by correcting the distribution of self-reported alcohol consumption using alcohol sales data. First, findings show that the gradient of social disparities in hazardous drinking differs between men and women. Men with lower education levels and lower SES are more likely to engage in hazardous drinking compared to their counterparts with higher education levels and higher SES, whereas the reverse relationship is observed in women. Second, self-report bias tends to mis-estimate social inequalities in hazardous drinking. Correcting for self-report bias increases estimates of social disparities in women, and decreases them in men, to the point that gradients are reversed in several countries. This paper thus suggests that policies must target at-risk population groups, but more essentially, that further refinements in survey techniques need to be undertaken in order to correctly assess and monitor risky drinking behaviours at the individual level.

The fourth paper assesses income-related inequities in health care services in 18 OECD countries, and investigates potential determinants of these inequalities at the national level. Health care services that are examined include: doctor visits (including general practitioner and specialist), dentist visits, and cancer screening. The magnitude of inequalities is measured by means of a concentration index corrected to take account of the cross-country variation in the prevalence of the studied health outcome. Findings show pro-rich inequities in doctor visits (strongly marked in specialist visits), as well as in dentist visits and cancer screening uptake. Although the investigation of the correlation with national characteristics was limited by the data, some relevant insights

emerged. Larger inequities were found in countries where: universal health coverage is not achieved, health care financing relies on a large share of private insurance and out-of-pocket payments, GPs do not act as gatekeepers, health care provision is mostly private, and national cost-sharing arrangements do not include free care at the point of delivery. Regarding policy implications, this paper shows that despite national objectives of equity in health care access, inequities related to level of income persist. Results suggest some possible avenues of health system reforms that may help to achieve equity in access to care, and they suggest that further monitoring of inequities in health care services utilisation is essential to assess the success of future policies.

2. Recommendations for research and policy implications

The findings presented in this thesis have important policy implications and support a number of recommendations for future research. Two main recommendations for research may be drawn from this work. First, this thesis highlights a number of limitations regarding data harmonisation and data availability. Further improvements need to be made at the international level to carry out surveys with harmonised questions for the sake of international comparisons, and to make data available in a timely manner to researchers. Second, while researchers and experts already pay attention to measuring and monitoring health inequalities, more efforts need to be undertaken regarding the understanding of inequalities in order to design more effective policy instruments to tackle inequalities (e.g. identifying the causal impact of determinants on health inequalities).

Regarding policy implications, the findings presented in this thesis highlight possible policy levers to help reduce social inequalities in health-related behaviours, and more generally reduce social inequalities in health. First, this thesis provides some evidence that, in order to achieve effective policy measures, it is relevant to focus on the most at-risk population groups, in particular groups with lower education levels and lower socioeconomic status among which a higher prevalence of risk factors is concentrated, as well as lower income groups who experience higher barriers in access to care. Better-targeted redistributive policies (e.g. cash transfers, social safety nets) combined with health policy measures directed at the worst-off (e.g. health literacy or prevention programmes) could help to reduce inequalities in health-related behaviours.

Second, as shown in this thesis, health and health inequalities are related to a number of dimensions like education, employment and income. This means that from a policy viewpoint, it is

worth considering these multi-sectorial relationships, and thus, putting health policy at the centre of a broader policy agenda. One can think for instance, of including objectives for health outcomes in other policy sectors (like education, employment, and social affairs). For example, in Japan, a chronic disease prevention programme at the workplace is being developed with the aim of maintaining people longer in work and in good health, and as a result, improving work productivity. Of course, such initiatives imply coordination across ministries, and in particular, discussion of financing arrangements (e.g. who pays? who gets the return?).

Third, the framework of this thesis assumes that tackling social inequalities in health can be achieved to some extent by addressing inequalities in health-related behaviours. In particular, unhealthy lifestyles such as smoking, heavy drinking and obesity are directly targetable by governments to favour better health outcomes. Governments can reduce behavioural risk factors by implementing policies to reduce unhealthy lifestyles, such as health promotion and regulatory policies. Regarding health promotion policies to tackle obesity, coordinated national programmes -including mass media campaigns and school-based interventions- are increasingly used by countries, such as the United States (*Let's move*), the United Kingdom (*Change4Life*), and also amongst EU member states with the 2014 European action plan targeting childhood obesity. Beyond the sole role of governments, the involvement of multi-stakeholders like the tobacco, alcohol and food industries, the community, and patient and doctor associations, appears a promising strategy in order to achieve the best outcomes. For instance, food manufacturers can play a role in the fight against obesity by reformulating the contents of products, this is the case for instance in Hungary after the fat tax implementation, and in the Netherlands after the compulsory food labelling implementation. Regarding regulatory policies, governments can employ taxation, advertising regulation, and location and time restrictions (for smoking and drinking). For example, to counter obesity, France, Hungary and Mexico have used taxation for sugar-sweetened beverages. One concern about taxation is its regressive effect on low income groups. However, some analyses show that low-socioeconomic groups benefit more from prevention policies in terms of health outcomes since they have a higher prevalence of risk factors (Sassi *et al*., 2009). Moreover, to counterbalance the side effects of taxation, redistributive measures can be used. For instance, financial gains raised from taxes could subsidize vouchers for healthy products or baskets of fruits and vegetables to the low-income groups adversely affected by the introduction of such taxes.

3. Possible extensions of the work

Research presented in this thesis highlights the need for possible extensions of the work and raises further questions that could be addressed in future investigations. Four possible avenues of work development are proposed here.

First, the analysis of the relationship between education and obesity sheds some light on the nature of the link and attempts to explore the causality. However, the investigation of the causal relationship was limited because -at the time of analysis- cross-sectional data were only accessible whereas longitudinal data would have allowed assessment of causality. In order to expand this analysis, it would be worth exploring the causal link using longitudinal data such as the *British Household Panel Survey*, or the *Household, Income and Labour Dynamics in Australia* survey.

Second, the study on inequalities in hazardous drinking highlights important weaknesses of survey data regarding the measurement of alcohol consumption. Alcohol consumption is highly underestimated in health surveys. A correction of survey data from underreporting was applied by using national alcohol sales data. This work could be extended by considering another correction technique which combines various types of questions (the usual quantity-frequency questions and the consumption in the day prior to the interview) (Meier *et al.*, 2013; Stockwell *et al.*, 2014). This would allow confirmation of the findings on the mis-estimation of social inequalities in hazardous drinking due to the underreporting bias in alcohol surveys.

Third, the work on health care services utilisation tries to inform the role of national policy settings on social inequalities, although this analysis is strongly limited by the small number of countries[25] and so, by the lack of variability at the country level. More robust analyses (like multilevel modelling) could be undertaken in future work if access to adequate data sets to increase the number of countries was made possible.

Fourth, while the study on health care services utilisation highlights persistent income-related inequalities, it may be worth examining the effect of the 2008 economic crisis on health care utilisation and assessing to what extend the crisis has led to larger social inequalities in health care access. A recent study shows that the crisis has contributed to a deterioration in access to health care, although the effects may vary across European countries (Eurofound, 2013). Similarly, the latest European data (from EU-SILC 2012) indicates increased unmet care needs in the aftermath of

[25] Around 8-10 countries depending on the health outcome studied.

the crisis among lower income groups (OECD, 2014). In the coming months, as new data are released, it will be possible to assess the impact of the crisis on the utilisation of health care services and on health outcomes by socioeconomic group.

REFERENCES

Eurofound (2013), *Impacts of the crisis on access to healthcare services in the EU*, Dublin.

Meier PS, Meng Y, Holmes J, Baumberg B, Purshouse R, Hill-McManus D, et al., (2013), "Adjusting for unrecorded consumption in survey and per capita sales data: Quantification of impact on gender- and age-specific alcohol-attributable fractions for oral and pharyngeal cancers in Great Britain". *Alcohol and Alcoholism*, 48(2): 241-249.

OECD (2014), *Health at a Glance Europe*, Paris.

Sassi F, Cecchini M, Lauer J, and Chisholm D. (2009), "Improving Lifestyles, Tackling Obesity: The Health and Economic Impact of Prevention Strategies". *OECD Health Working Paper 48*.

Stockwell T, Zhao J, and Macdonald S. (2014), "Who under-reports their alcohol consumption in telephone surveys and by how much? An application of the 'yesterday method' in a national Canadian substance use survey". *Addiction*, doi:10.1111/add.12609.

Inégalités sociales des comportements de santé: L'herbe est-elle plus verte ailleurs?

Marion Devaux

Résumé : Cette thèse traite des inégalités sociales en matière de comportements de santé tels que les modes de vie liés à la santé (spécifiquement, l'obésité et la consommation d'alcool) et l'utilisation des services de santé, dans plusieurs pays de l'OCDE. Ce travail repose sur une approche micro-économétrique et utilise un grand nombre de bases de données nationales. Les objectifs de cette thèse sont de: (1) comparer les inégalités sociales de comportements de santé entre des pays ayant des caractéristiques différentes, (2) apporter un éclairage à la compréhension des disparités sociales des comportements de santé, et enfin (3) examiner comment l'auto-déclaration peut affecter l'évaluation des comportements de santé, et donc affecter la mesure des inégalités.

Mots-clés : Inégalité sociale ; Obésité ; Alcool ; Accès aux soins ; Biais de déclaration ; Comparaison internationale

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Social Inequalities in Health-Related Behaviours: Is the grass greener on the other side?

Marion Devaux

Summary: This thesis deals with social inequalities in health-related behaviours such as lifestyle risk factors for health (precisely, obesity and alcohol consumption) and the utilisation of health care services, in a number of OECD countries. This work relies on an applied micro-economics approach, using several national health survey data. This thesis aims to (a) compare social inequalities in health-related behaviours across countries with different settings; (b) shed light on the understanding of social disparities in health-related behaviours; and (c) examine how self-reporting may affect the rating of behavioural risk-factors, and therefore affect the measurement of social inequalities.

Key words: Social inequalities; Obesity; Alcohol; Health care access; Reporting bias; International comparison