



Santé mentale et tabagisme pendant la pandémie de COVID-19 : étude des déterminants sociaux

Astrid Juhl Andersen

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en épidémiologie sociale (ERES)*

Mental health and smoking behaviour during the COVID-19 pandemic: investigating social determinants

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Thèse de doctorat d'Epidémiologie sociale

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This thesis was carried out in the Research Team in Social Epidemiology (ERES, French acronym for Equipe de Recherche en Epidémiologie Sociale) at the Pierre Louis Institute of Epidemiology and Public Health (IPLESP, French Acronym for Institut Pierre Louis d'Epidémiologie et de Santé Publique, UMRS 1136), a research laboratory under the joint supervision of Sorbonne University and INSERM. The thesis work was carried out from January 2021 to September 2023, under the supervision of Maria Melchior and Murielle Mary-Krause. This thesis was founded by the French Institute for Public Health Research (IReSP) and the French Institute of Cancer (INCa), within the framework of the call for doctoral grants launched in 2020, under the project reference number “AAC-SPA-04”.

Abstract for general audience

English

In 2020, the COVID-19 pandemic caused global disruption, prompting rapid sanitary measures that altered daily life. This thesis delves into the pandemic's effects on mental health and smoking patterns. The objective is to understand how pre-existing mental health conditions rendered individuals vulnerable during the pandemic, and how smoking behaviours shifted. By studying these conditions, the aim is to illuminate health inequalities during crises.

The research included up to seven assessments of anxiety and/or depression symptoms between March and May 2020. It found an increased risk of experiencing such issues for individuals with pre-existing symptoms, as well as for females and those experiencing loneliness during the initial pandemic phase.

The thesis's second focus was on smoking prevalence, especially among different levels of education. The analysis spanned from 2009 to 2020, revealing that lower education was associated with higher smoking prevalence; and that those with higher education were more likely to reduce tobacco use compared to their less educated counterparts, thereby widening the social inequality gap in smoking prevalence.

The third aspect investigated intergenerational social mobility (the advancement or decline of children's socio-economic status compared to that of their parents) and its impact on mid-life smoking patterns. Results highlighted the social gradient in smoking behaviour and revealed that upward mobility provided protection against long-term smoking.

This thesis highlights the importance of addressing mental health and smoking at the outset of crises, whether they are related to health, climate, or the economy, in order to reduce social inequalities in health.

French

En 2020, la pandémie de COVID-19 a provoqué une perturbation mondiale, entraînant rapidement la mise en place de mesures sanitaires qui ont changé la vie quotidienne des personnes. Cette thèse étudie les effets de cette pandémie sur la santé mentale et les habitudes tabagiques. L'objectif est de comprendre comment les troubles de santé mentale préexistants ont rendu les individus plus vulnérables, et comment les comportements tabagiques ont évolué durant cette pandémie, afin de mettre en lumière de potentielles inégalités sociales de santé.

La première recherche a porté sur sept évaluations de l'anxiété et de la dépression entre mars et mai 2020. Elle a révélé un risque plus élevé de présenter de tels troubles au cours de la pandémie pour les personnes qui en présentaient déjà avant, chez les femmes, et les personnes souffrant de solitude durant la phase précoce de la pandémie.

La deuxième partie de la thèse s'est intéressée à la prévalence du tabagisme, selon le niveau d'éducation. L'analyse, qui couvre la période 2009-2020, révèle qu'un faible niveau de diplôme est associé à une prévalence du tabagisme plus élevée comparativement à un niveau d'éducation supérieur, les personnes présentant un niveau supérieur étant plus susceptibles de réduire leur consommation de tabac, creusant ainsi le fossé des inégalités sociales.

Le troisième volet a porté sur la mobilité sociale intergénérationnelle (progression ou régression du statut socio-économique des enfants par rapport à leurs parents) et son impact sur les habitudes tabagiques. Les résultats ont mis en évidence un gradient social dans le comportement tabagique, la mobilité ascendante sur l'échelle sociale protégeant contre le tabagisme à long terme.

Cette thèse souligne l'importance de s'attaquer aux problèmes de santé mentale et au tabagisme dès le début des crises afin de réduire les inégalités en matière de santé.

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French summary of thesis

Introduction :

En 2020, le monde entier a été confronté à la pandémie de COVID-19, entraînant des changements majeurs dans la vie quotidienne de chacun. Dès le début de la pandémie, la santé mentale et les comportements en matière de santé ont connu une dégradation. Des études ont montré une association entre l'anxiété et/ou la dépression et une augmentation de la consommation de substances psychoactives, y compris le tabagisme (Cougle et al., 2010). Ainsi, les niveaux accrus d'anxiété et de dépression signalés pendant la pandémie pourraient avoir affecté négativement la baisse de la prévalence du tabagisme observée ces dernières années (Pasquereau et al., 2021). Des changements dans le comportement des fumeurs pendant la pandémie de COVID-19 pouvaient être prévisibles, à la fois pour faire face à des niveaux accrus d'anxiété et de dépression, mais aussi en raison des nouvelles circonstances quotidiennes qui, pour la plupart des gens, signifiaient de nouvelles habitudes, la peur de l'infection et moins de rencontres sociales. Dans le cadre de ce projet de doctorat, j'ai étudié les facteurs, que l'on sait être associé aux inégalités sociales de santé, pendant la pandémie de COVID-19. Plus précisément, j'ai examiné l'association entre les symptômes préexistants d'anxiété et/ou de dépression et la survenue de tels symptômes pendant l'épidémie de COVID-19. J'ai également étudié l'association entre le niveau de diplôme et les changements dans le comportement tabagique de 2018 à 2021. Le tabagisme étant connu pour être associé aux inégalités socio-économiques en matière de santé et de comportement de santé, j'ai étudié l'association entre la mobilité sociale intergénérationnelle et les trajectoires de tabagisme chez les adultes en milieu de vie.

Ce projet de doctorat s'inscrit dans le cadre de l'épidémiologie sociale. Pour étudier les différents objectifs, nous avons utilisé les données de deux cohortes françaises : 1) la cohorte TEMPO (Trajectoires ÉpidéMiologiques en Population), en particulier l'étude TEMPO-COVID-19, et 2) la cohorte CONSTANCES.

Contexte :

La pandémie COVID-19 en France et le confinement associé

À partir de février 2020, le monde a été fortement touché par la crise sanitaire mondiale liée à la pandémie de COVID-19, causée par le coronavirus 2 du syndrome respiratoire aigu sévère (SARS-CoV-2), qui a actuellement entraîné plus de 6,9 millions de décès dans le monde (World Health Organization, 2023). Pour lutter contre la pandémie, le gouvernement français, à l'instar

de nombreux autres pays, a mis en place des confinements nationaux à plusieurs reprises, à partir de mars 2020. Tout au long de ces périodes, de sévères restrictions ont été imposées au niveau des interactions sociales, des déplacements, des modalités de travail, et de l'accès aux services et aux soins de santé, comprenant des limitations des services de médecine préventive et générale (Delamaire et al., 2021; Topriceanu et al., 2021).

Santé mentale et COVID-19

En raison des restrictions sévères imposées pendant la période du COVID-19, ainsi que des divers confinements, le monde scientifique s'est beaucoup intéressé à la manière dont les changements de mobilité, l'isolement social, la situation économique, et la peur de l'infection et de la mortalité affecteraient la santé mentale des personnes, à la fois de manière aiguë et à long terme. Au début de la pandémie, des niveaux accrus d'anxiété et de dépression ont été signalés tant en France (Santé Publique France, 2020) qu'au niveau international (Santomauro et al., 2021; World Health Organization, 2023). Depuis l'apparition de la maladie, les adultes français semblent présenter une prévalence particulièrement élevée de détresse psychologique, englobant le stress et l'anxiété, par rapport aux autres pays de l'OCDE (OECD, 2021a). En France, la prévalence de la détresse psychologique est passée de 10,0 % en 2017 à 19,9 % en 2020 (données utilisées par l'agence nationale de santé publique (Santé Publique France)), enregistrant une augmentation relativement importante au cours de la période (OECD, 2021a).

Données sur santé mentale et COVID-19

Des recherches menées lors d'épidémies antérieures ont montré que la quarantaine avait un impact important sur la santé mentale (Brooks et al., 2020), et que les symptômes d'anxiété et de dépression restaient élevés pendant et plusieurs mois après les épidémies (Jalloh et al., 2018; Jeong et al., 2016; Wu et al., 2009). Il a été souligné que les inégalités socio-économiques, la pauvreté, le chômage, l'insécurité alimentaire, les soutiens sociaux, la quarantaine, et l'inactivité physique pouvaient servir de facteurs médiateurs de l'impact de la pandémie sur la santé mentale (Campion et al., 2020). D'autres explications du stress accru résultant de l'isolement social pendant la pandémie incluent la capacité des gens à travailler, à chercher du soutien auprès de leurs proches et à s'engager dans leur communauté (World Health Organization, 2022a). L'attention portée à la manière dont la pandémie pourrait avoir un impact négatif sur la santé mentale a conduit au développement rapide de nombreux projets de recherche visant à évaluer cet impact. Les premières recherches, telles que les enquêtes descriptives auprès de la population, ont suggéré une augmentation globale de la prévalence des problèmes de santé

mentale dans diverses populations (Dragioti et al., 2022; Liu et al., 2021; Pierce et al., 2020; Santomauro et al., 2021; Sousa et al., 2021; Wu et al., 2021).

Objectif de recherche 1 : Santé mentale préexistante et COVID-19

Au début du travail de thèse, peu de recherches avaient été publiées concernant la santé mentale pendant la pandémie de COVID-19. L'objectif du premier travail de cette thèse était donc de contribuer à mieux comprendre le rôle des difficultés de santé mentale préexistantes vis-à-vis des symptômes d'anxiété/dépression pendant la première période de confinement à partir de données longitudinales.

Tabagisme et COVID-19

Des recherches passées montrent que le tabagisme est associé à une santé mentale dégradée (Prochaska et al., 2017). À une époque où la prévalence des problèmes de santé mentale augmente, comme pendant la pandémie, il était donc intéressant d'examiner les changements concomitants dans les habitudes tabagiques. Malgré le fait que le tabagisme est la principale cause de décès évitable en population générale, il est encore très répandu (World Health Organization, 2021). Dans le monde, on estime que 1,3 milliard de personnes consomment des produits du tabac et que le nombre de décès liés au tabac dépasse les 8 millions par an (World Health Organization, 2021). Par conséquent, le tabagisme figure parmi les principaux facteurs de mortalité prématurée et contribue à l'une des plus grandes menaces pour la santé publique à laquelle le monde ait jamais été confronté. Au sein de la population française, la prévalence du tabagisme est élevée par rapport à d'autres pays occidentaux (24% de fumeurs en France contre 16% en moyenne dans les pays de l'OCDE) (OECD, 2021b).. Dans le monde occidental, les taux de tabagisme ont généralement baissé, mais cette baisse a été nettement plus rapide chez les personnes ayant un statut socio-économique élevé que chez les personnes plus défavorisées (Phelan et al., 2010). Un rapport publié par Santé Publique France en 2021, basé sur 10 enquêtes transversales répétées et représentatives au niveau national menées auprès de la population française âgée de 18 à 75 ans, a montré l'évolution de la prévalence du tabagisme en fonction du niveau d'éducation faisant état d'inégalités sociales (Pasquereau et al., 2021).

Des données recueillies en France et dans d'autres pays suggèrent que le comportement tabagique pendant la pandémie de COVID-19 a été affecté de différentes manières. Dans une étude systématique et une méta-analyse réalisées en 2022, Sarich et ses collègues ont examiné les changements dans les habitudes tabagiques au cours des phases initiales de pré-vaccination de la pandémie de COVID-19 et ont conclu que les résultats étaient mitigés (Sarich et al., 2022).

Cela vaut non seulement pour le nombre de personnes ayant modifié leur comportement, mais aussi pour la direction du changement. Une autre revue systématique, qui a intégré 11 études longitudinales et qui a été publiée en 2022, a constaté que la plupart de ces études montraient une réduction du nombre de cigarettes consommées entre la période précédant la pandémie et la période de la pandémie. Seules deux études ont fait état d'une augmentation de la consommation de cigarettes entre le début et la fin de l'étude (Almeda and Gómez-Gómez, 2022). Une méta-analyse récente, publiée en 2023 par Bakaloudi et ses collègues, a inclus un total de 77 études et a constaté que pour 34 d'entre elles, une augmentation du tabagisme avait été observée chez la majorité des participants. Dans 21 études, aucun changement significatif n'a été constaté, tandis que 18 études ont indiqué une diminution du tabagisme comme réponse prédominante (Bakaloudi et al., 2023).

Objectif de recherche 2 : Changements dans le comportement tabagique au cours de la pandémie de COVID-19

Sur la base de l'hypothèse de changements dans les habitudes tabagiques, et la nécessité d'analyses de sous-groupes, le deuxième objectif de recherche de cette thèse a été d'étudier la prévalence du tabagisme de 2009 à 2021, en se concentrant sur les différences entre les niveaux d'éducation. Nous avons également étudié l'association entre les changements dans le comportement tabagique de 2018 à 2021 et les niveaux d'éducation.

Mobilité sociale et tabagisme

De nombreuses études ont mis en évidence le gradient social en matière de tabagisme, démontrant que les personnes ayant un niveau d'éducation et un statut socio-économique plus faibles présentent des taux de tabagisme plus élevés (Hiscock et al., 2012). Cette tendance ne se limite pas à la France, elle se vérifie à l'échelle internationale. Les groupes défavorisés, notamment les chômeurs de longue durée, les personnes sans-abri, celles souffrant de troubles mentaux, les parents isolés, et certaines populations immigrées et des minorités ethniques, affichent des taux de tabagisme particulièrement élevés (Hiscock et al., 2012). En outre, ces groupes sont plus susceptibles de subir les effets négatifs du tabac sur leur santé et une mortalité accrue associée au tabagisme, les groupes défavorisés étant nettement plus susceptibles de mourir de causes liées au tabagisme que les fumeurs plus privilégiés (ibid.). Les facteurs qui ont été identifiés comme prédictors du tabagisme comprennent le statut marital, les privations culturelles, et les indicateurs de situations maritales, personnelles et domestiques stressantes - à savoir tout marqueur de désavantage dans les sociétés industrialisées occidentales (Marmot

et al., 2005). L'interaction complexe des facteurs socio-économiques, de la transmission intergénérationnelle et du niveau d'éducation individuel influence les taux de tabagisme et les inégalités à différents stades de la vie. Il est essentiel de comprendre ces relations pour s'attaquer aux inégalités persistantes en matière de santé associées au tabagisme et à la situation socio-économique.

Objectif de recherche 3 : Mobilité sociale intergénérationnelle et trajectoires tabagiques au milieu de la vie

Le troisième objectif de cette thèse a été d'étudier l'association entre la mobilité sociale intergénérationnelle et les trajectoires tabagiques au milieu de la vie, en utilisant les données de la cohorte CONSTANCES.

Article 1 1 : Symptômes d'anxiété/dépression pendant la pandémie de COVID-9 et le confinement associé, en population générale : données longitudinales de la cohorte TEMPO en France

La pandémie de COVID-19 et les mesures préventives associées ont eu un impact sur la santé mentale des personnes, notamment en augmentant le risque de symptômes d'anxiété et de dépression. Les personnes ayant déjà eu des problèmes de santé mentale constituent un groupe particulièrement vulnérable, mais peu d'études ont testé cette hypothèse d'association entre le COVID-19 et la survenue d'anxiété et/ou de dépression de manière empirique en tenant compte des problèmes de santé mentale préexistants. L'objectif de cette étude a été d'examiner l'association longitudinale entre les symptômes préexistants d'anxiété/dépression et les symptômes d'anxiété/dépression pendant le confinement dû à la pandémie de COVID-19 dans un échantillon de la population générale.

Des modèles d'équations d'estimation généralisées ont été utilisés pour estimer cette association chez 662 personnes de 25 à 45 ans de la cohorte française TEMPO. Sept vagues de collecte de données ont été mises en œuvre de mars à mai 2020. Les personnes présentant des symptômes d'anxiété/dépression avant le confinement ont eu 6,73 fois plus de risque [$IC_{95\%} = 4,45-10,17$] de présenter des symptômes d'anxiété/dépression pendant le confinement que les personnes n'ayant pas de tels antécédents. La probabilité de symptômes d'anxiété/dépression pendant la pandémie de COVID-19 était plus élevée chez les femmes ($OR = 2,07$ [$IC_{95\%} = 1,32-3,25$]), les sujets ayant un faible revenu familial ($OR = 2,28$ [$IC_{95\%} = 1,29-4,01$]), et les personnes souffrant d'isolement ($OR = 3,94$ [$IC_{95\%} = 2,47-6,28$]).

Cette étude a permis de mettre en évidence une forte relation entre les symptômes préexistants d'anxiété/dépression et la survenue de tels symptômes pendant l'épidémie de COVID-19 chez les adultes français d'âge moyen. Ces résultats soulignent le rôle des symptômes préexistants d'anxiété/dépression en tant que facteur de vulnérabilité de l'anxiété/dépression pendant le confinement. En outre, l'étude a montré que le sentiment de solitude était associé de manière indépendante aux symptômes d'anxiété/dépression, après ajustement sur les antécédents de symptômes d'anxiété/dépression avant la pandémie.

Article 2 : Avons-nous été exposés de manière équitable au changement de comportement vis-à-vis du tabac lors d'une crise de santé publique ? Impact du niveau d'éducation sur le tabagisme dans la cohorte TEMPO

Depuis 2020, la pandémie de COVID-19 a considérablement affecté la population, avec notamment une augmentation significative des problèmes de santé mentale. Le tabagisme étant fortement associé aux problèmes de santé mentale, la pandémie pourrait avoir influencé la baisse des taux de tabagisme observée ces dernières années. Les personnes appartenant à des groupes défavorisés sur le plan socio-économique pourraient être particulièrement touchées, à la fois parce que la pandémie exacerbe les inégalités sociales existantes, et parce que ce groupe était plus susceptible de fumer avant la pandémie. Nous avons examiné la prévalence du tabagisme dans une étude de cohorte française, en nous concentrant sur les différences selon les niveaux d'éducation. Nous avons également examiné l'association entre les changements interpersonnels dans la consommation de tabac et le niveau de diplôme, de 2018 à 2020, et de 2020 à 2021.

L'étude de cohorte TEMPO a inclus 1785 adultes français suivis entre 1991 et 2021. Avec quatre évaluations du statut tabagique disponibles avant le début du COVID-19, et deux après, nous avons estimé la prévalence du tabagisme au cours du temps, stratifiée selon le diplôme le plus élevé obtenu. Nous avons étudié l'évolution interpersonnelle du statut tabagique entre 2018 et 2020 chez 596 sujets à l'aide d'une régression logistique multinomiale. La pondération par l'inverse de la probabilité a été utilisée pour tenir compte de la non-réponse. La prévalence des fumeurs a toujours été plus élevée chez les personnes ayant un faible niveau d'éducation comparativement à celles ayant un diplôme supérieur. Toutefois, la différence entre les deux groupes s'est accrue entre 2020 et 2021 (de 4,8 % à 9,4 %). Les fumeurs ayant un faible niveau d'éducation étaient moins susceptibles de réduire leur consommation de tabac entre 2018 et 2020 que les fumeurs ayant un niveau d'éducation plus élevé (OR=2,69 [IC_{95%} = 0,87;8,38]).

Les résultats actuels montrent une augmentation de l'écart socio-économique au fil du temps en ce qui concerne les taux de tabagisme, ce qui souligne la vulnérabilité des personnes peu diplômées face au tabagisme, exacerbé pendant la pandémie.

Article 3 : Trajectoires du statut tabagique, mobilité socio-économique intergénérationnelle et dépression : Résultats de 107 734 adultes français (18 à 75 ans) de la cohorte CONSTANCES

Le tabagisme reste un problème de santé publique important, bien qu'il s'agisse d'une cause bien établie de cancer. Dans les pays industriels, la prévalence du tabagisme est disproportionnellement élevée dans les communautés à faible revenu en raison de taux d'initiation plus élevés et de taux d'arrêt plus faibles. La mobilité sociale intergénérationnelle (MSI), c'est-à-dire la relation entre le statut socio-économique des parents et celui de leurs enfants, a un impact sur le tabagisme à l'adolescence. Toutefois, la relation entre la mobilité sociale intergénérationnelle et les trajectoires de tabagisme au milieu de la vie reste peu étudiée. Pour combler cette lacune, la présente étude vise à examiner la relation entre MSI et les trajectoires tabagiques au milieu de la vie, en utilisant les données de la cohorte CONSTANCES, un échantillon représentatif de la population générale française.

La modélisation des trajectoires de consommation de tabac à partir de la méthode « Group-based trajectory modeling (GBTM) » a été réalisée afin d'identifier les groupes de fumeurs parmi les 166 459 participants. Une analyse par régression logistique multinomiale a ensuite été réalisée pour estimer l'association entre la MSI et les trajectoires tabagiques, en tenant compte des facteurs de confusion potentiels. L'imputation multiple a été utilisée pour tenir compte des données manquantes. Trois groupes de trajectoires tabagiques ont été identifiés : non-fumeurs ou anciens fumeurs (76,1%), arrêt du tabac à l'âge adulte (14,6%), et tabagisme de longue durée (9,3%). Les résultats ont montré que la mobilité ascendante était associée à une diminution du risque de tabagisme à long terme par rapport aux personnes ayant une mobilité élevée/intermédiaire persistante (OR=0,80 [IC_{95%}=0,76;0,85]), tandis que la mobilité descendante ou la faible mobilité persistante était associée à une augmentation du risque de tabagisme à long terme (OR=1,41 [IC_{95%}=1,32;1,50] et OR=1,58 [IC_{95%}=1,49;1,68], respectivement). Par ailleurs, la mobilité ascendante et la persistance d'un faible niveau de vie étaient toutes deux associées à une probabilité plus faible d'arrêter de fumer au cours de la période d'étude (OR=0,85 [IC_{95%}= 0,80;0,91] et OR=0,85 [IC_{95%}=0,78;0,93], respectivement).

L'étude a mis en évidence l'impact de la mobilité sociale intergénérationnelle sur les trajectoires tabagiques à l'âge adulte. La mobilité ascendante est associée à une diminution du risque de tabagisme à long terme, tandis que la mobilité descendante ou la faible mobilité persistante augmente ce risque. Les efforts visant à améliorer la mobilité sociale intergénérationnelle peuvent avoir un impact positif sur le comportement tabagique et réduire le fardeau des maladies liées au tabac.

Discussion :

Santé mentale et COVID-19

Cette thèse a apporté de nouvelles données sur la santé mentale et les conduites addictives en population générale, à un moment où les connaissances sur les groupes vulnérables pendant la pandémie étaient limitées. Elle a démontré que les personnes présentant des symptômes préexistants d'anxiété ou de dépression étaient plus susceptibles de souffrir de tels symptômes au début de la pandémie. Ces résultats sont conformes à ceux publiés par Santé Publique France, qui indiquent que la prévalence de l'anxiété et de la dépression était la plus élevée au début de la pandémie. Les publications scientifiques postérieures, qui ont étudié l'évolution des troubles de la santé mentale avant et après la pandémie, n'ont pas montré de détérioration (Witteveen et al., 2023). Witteveen et al. ont notamment souligné, dans leur méta-analyse de la santé mentale et du COVID-19, que cette incohérence semble aller à l'encontre de résultats antérieurs indiquant une plus grande vulnérabilité chez les personnes ayant des antécédents de troubles mentaux, ce que nous avons également observé dans notre étude. Cette incohérence dans la littérature peut s'expliquer par plusieurs facteurs. L'un d'entre eux est l'importante variation individuelle de symptômes parmi les personnes atteintes de troubles mentaux, la pandémie et la mise en œuvre de mesures de santé publique ayant entraîné une augmentation des symptômes d'anxiété et de dépression chez certaines personnes, tout en s'avérant bénéfique pour d'autres, par exemple en réduisant la pression sociale (Witteveen et al., 2023). Notre étude incluait une majorité de personnes ayant un statut socio-économique élevé (Mary-Krause et al., 2021), les personnes souffrant de troubles psychiatriques plus graves n'ayant peut-être pas été incluses dans la cohorte TEMPO. Par conséquent, nos résultats s'appliquent à un groupe très spécifique de personnes pour lesquelles nous étudions les symptômes d'anxiété/dépression.

Tabagisme et COVID-19

Nos résultats concernant le tabagisme doivent être considérés dans le contexte des études existantes sur le sujet, montrant des résultats mitigés. Comme l'ont souligné Sarich et al. (2022),

des résultats divergents ont été rapportés concernant les changements dans les habitudes de tabagisme avant et pendant la pandémie. Il est essentiel d'examiner l'influence du niveau d'éducation sur les comportements tabagiques pendant la pandémie de COVID-19, et de comprendre quels groupes démographiques sont les plus susceptibles de modifier leurs habitudes tabagiques, afin d'obtenir des informations précieuses pour élaborer des politiques de santé publique efficaces. Il est essentiel d'identifier à la fois les populations vulnérables et les facteurs associés à la prévalence du tabagisme, car les effets néfastes du tabagisme varient en fonction du statut socio-économique. Au cours de la rédaction de la thèse, il est devenu de plus en plus évident que la littérature émergente présentait une limite majeure. La façon dont les changements dans le tabagisme pendant la pandémie de COVID-19 ont été mesurés dans les études épidémiologiques a varié, ce qui pourrait contribuer aux différences entre les conclusions tirées de ces études. En particulier, étant donné que la pandémie de COVID-19 a fortement perturbé les habitudes des individus, il a pu être particulièrement difficile pour ces derniers de suivre rétrospectivement leur consommation de tabac. La plupart des études portant sur l'évolution du tabagisme se fondent principalement sur des questions d'enquête autodéclarées concernant les changements perçus dans les habitudes tabagiques (Bast et al., 2023; Nagawa et al., 2023; Wiley et al., 2023), qui pourrait être sujette à l'imprécision (Hipp et al., 2020).

Tabagisme et mobilité sociale intergénérationnelle

La troisième partie de la thèse a contribué à une meilleure connaissance de la relation entre la mobilité sociale intergénérationnelle en tant que mesure du statut socio-économique à deux stades de la vie, et des trajectoires de tabagisme au milieu de la vie. Nos résultats montrent un gradient social dans le comportement tabagique, avec, en particulier, la mobilité ascendante comme facteur protecteur sur le tabagisme à long terme. Ces résultats sont conformes à notre hypothèse et donnent un nouvel aperçu de la mobilité sociale et des trajectoires de tabagisme chez les adultes d'âge moyen en France. Les recherches antérieures sur la mobilité sociale et le tabagisme se sont principalement concentrées sur le tabagisme à l'adolescence, mais il est essentiel de connaître les tendances du tabagisme chez les adultes.

Nous avons constaté que les individus qui ont un faible statut socio-économique à la fois dans l'enfance et à l'âge adulte avaient la plus forte probabilité de fumer sur le long terme, par rapport à ceux qui avaient un statut socio-économique élevé à la fois dans l'enfance et à l'âge adulte. Pour les personnes qui ont connu une mobilité descendante, passant d'un statut socio-économique élevé pendant l'enfance à un statut socio-économique faible à l'âge adulte, nous avons également identifié une probabilité accrue de tabagisme sur le long terme, bien que

l'ampleur de l'effet soit moindre que pour les personnes ayant un statut socio-économique faible et persistant. Ce résultat suggère que le fait de grandir dans un ménage plus favorisé réduit la probabilité de fumer sur le long terme par rapport au fait de grandir dans un ménage à faible statut socio-économique. L'expérience d'une mobilité ascendante, c'est-à-dire le passage d'un statut socio-économique faible à un statut socio-économique plus élevé, est associée à une probabilité plus faible de tabagisme à long terme par rapport à un statut socio-économique constamment élevé, ce qui suggère un effet protecteur de la mobilité ascendante en ce qui concerne le tabagisme. Les effets de la mobilité descendante et ascendante suggèrent que les adultes sont susceptibles d'adopter le comportement de leur groupe de destination, ce qui est conforme aux études précédentes (Bowes et al., 2013; Doku et al., 2020; Kuntz and Lampert, 2013). Ces résultats indiquent également l'importance de l'environnement social dans le comportement tabagique.

Limites méthodologiques

Malgré ses points forts, cette thèse présente certaines limites. La validité de nos résultats dépend de l'utilisation des mesures longitudinales disponibles pour évaluer les problèmes de santé mentale, le statut tabagique et le statut socio-économique. Comme dans toute étude de cohorte, certaines données peuvent être manquantes. Dans la première étude, nous n'avons pas été confrontés à ce problème, car l'analyse était basée sur des cas complets, excluant de l'analyse les individus ayant des informations manquantes. Cette approche peut avoir entraîné un biais de non-réponse. Dans la deuxième étude, nous avons utilisé les inverse probability weights (IPW) pour tenir compte de l'attrition de l'échantillon initial, ce qui a permis d'atténuer une partie du biais lié aux données manquantes. Dans la troisième étude, qui s'est appuyée sur les données de la cohorte CONSTANCES, nous avons géré les informations manquantes en mettant en œuvre des techniques d'imputation multiple pour les données.

La généralisation des résultats à la population générale nécessite de disposer d'un échantillon représentatif de cette population. La cohorte TEMPO a été créée en 2009 dans le but d'améliorer la compréhension des problèmes et des besoins de santé des jeunes adultes (Mary-Krause et al., 2021). Par conséquent, les participants à TEMPO constituent une population d'étude spécifiquement choisie dès le départ, et ne reflètent donc pas la population française générale. L'attrition au sein des cohortes est inévitable et non aléatoire, les individus les plus défavorisés étant plus susceptibles d'être perdus de vue que leurs homologues moins défavorisés (Howe et al., 2013). En raison de cette attrition sélective, la cohorte TEMPO présente une

surreprésentation de femmes, de personnes ayant un statut socio-économique plus élevé et de personnes moins susceptibles de fumer (Mary-Krause et al., 2021).

Le moment de la collecte des données peut avoir influé sur nos résultats. Il est possible que les changements en matière de santé mentale et de tabagisme aient été plus fréquents à certains moments de la pandémie, en particulier les symptômes d'anxiété et de dépression atteignant leur paroxysme au début de la pandémie. On peut donc émettre l'hypothèse que les changements en matière de santé mentale et de comportement tabagique pourraient être influencés à des degrés divers à des périodes distinctes, ce qui limiterait la généralisation de nos résultats à une période non spécifique.

Perspectives :

Les recherches menées pendant la pandémie de COVID-19 ont montré qu'il est essentiel de se concentrer sur les personnes vulnérables pour faire face aux crises futures. Nous avons identifié deux groupes particulièrement vulnérables pendant la pandémie : les personnes souffrant de troubles mentaux préexistants et les personnes ayant un faible niveau d'éducation, pour ce qui concerne leur santé mentale et leur comportement tabagique pendant cette période. Ce point est important en raison des inégalités potentielles dans les conséquences de la pandémie et dans les conséquences négatives potentielles à long terme sur la santé. Des études ont révélé que l'impact économique et financier de la pandémie a été plus important chez les personnes ayant un faible statut socio-économique (Firlej and Pawlowski, 2021). Par ailleurs, les personnes à faible revenu sont plus touchées par les conséquences de la crise, les niveaux d'anxiété et de dépression étant plus élevés chez les personnes dont le revenu du ménage est faible (Andersen et al., 2021; Fancourt et al., 2021; Pieh et al., 2020), ces deux facteurs étant associés à des taux de tabagisme élevés. De plus, les pertes d'emploi ont explosé pendant la pandémie, affectant de manière disproportionnée les personnes qui étaient déjà économiquement vulnérables avant le début de la pandémie de COVID-19 (Ksinan Jiskrova et al., 2021). Il est important de garder ces connaissances à l'esprit lorsqu'il s'agira de faire face à de futures crises sanitaires, climatiques ou économiques.

Le débat sur les comportements liés à la santé, comme le tabagisme, tend souvent à s'inscrire dans le contexte de la responsabilité individuelle, sans tenir compte des facteurs sociétaux plus larges qui entrent en jeu (Marmot et al., 2005). Cette approche qui consiste à blâmer les victimes ne tient pas compte des raisons pour lesquelles les personnes défavorisées sont plus susceptibles d'adopter des comportements néfastes pour leur santé, comme par exemple le tabagisme. Elle

néglige également l'interaction complexe des influences sociales et individuelles qui perpétuent ces comportements. Se contenter d'exhorter les individus à changer de comportement, sans aborder les circonstances sociales sous-jacentes, est inutile et inefficace pour promouvoir le changement de comportement au sein des groupes défavorisés (Marmot et al., 2005).

Conclusion :

En conclusion, ce travail a mis en évidence le fait que les personnes ayant des problèmes de santé mentale préexistants risquaient davantage de présenter des symptômes d'anxiété ou de dépression au cours de la phase initiale de la pandémie de COVID-19. En outre, pendant la pandémie, les personnes ayant un niveau d'éducation élevé étaient plus susceptibles de réduire leur consommation de tabac que celles ayant un niveau d'éducation plus faible. Par conséquent, la disparité de la prévalence du tabagisme entre les personnes ayant un faible niveau d'éducation et celles ayant un niveau d'éducation élevé s'est accrue entre la période pré- et post-pandémique. Étant donné l'impact des problèmes de santé mentale et du tabagisme sur les inégalités sociales de santé, la prévention précoce et la promotion de la santé sont nécessaires dès le début d'une crise. De plus, les conséquences de la pandémie de COVID-19 soulignent la nécessité d'une vigilance accrue pour éviter l'exacerbation des disparités de santé liées au statut socio-économique.

Nous avons également pu montrer que la mobilité sociale intergénérationnelle était associée aux habitudes tabagiques chez les adultes. La mobilité ascendante était associée à un risque plus faible de tabagisme à long terme par rapport aux non-fumeurs ou aux anciens fumeurs, en comparaison avec les personnes ayant une mobilité élevée/intermédiaire persistante. À l'inverse, la mobilité descendante ou la faible mobilité persistante était associée à un risque accru de tabagisme à long terme. En outre, la mobilité ascendante et la persistance d'un statut socio-économique faible étaient associées à une probabilité plus faible d'arrêter de fumer par rapport aux non-fumeurs ou aux anciens fumeurs pendant la durée de l'étude. Ces résultats montrent l'importance de l'environnement social dans le comportement tabagique.

List of publications and presentations

Publications in peer-reviewed journals

Published papers as first author

1. Astrid Juhl Andersen, Murielle Mary-Krause, Joel José Herranz Bustamante, Mégane Héron, Tarik El Aarbaoui, and Maria Melchior. 2021. “Symptoms of Anxiety/Depression during the COVID-19 Pandemic and Associated Lockdown in the Community: Longitudinal Data from the TEMPO Cohort in France.” *BMC Psychiatry* 21 (1): 381.
<https://doi.org/10.1186/s12888-021-03383-z>
2. Astrid Juhl Andersen, Irwin Hecker, Solène Wallez, Anke Witteveen, Antonio Lora, Ellenor Mittendorfer-Rutz, Giovanni Corrao, et al. 2023. “Are We Equally at Risk of Changing Smoking Behavior during a Public Health Crisis? Impact of Educational Level on Smoking from the TEMPO Cohort.” *BMC Public Health* 23 (1): 1016.
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3. Astrid Juhl Andersen, Solène Wallez, Maria Melchior, Murielle Mary-Krause. 2023. “Investigating discrepancy in individuals’ perception and actual changes in cigarette smoking: the TEMPO cohort study.” Submitted at PLOS ONE. October 2023.
4. Astrid Juhl Andersen, Emmanuel Wiernick, Simon Ducarroz, Marcel Goldberg, Marie Zins, Murielle Mary-Krause, Maria Melchior. 2023. “Intergenerational Social Mobility and Smoking Trajectories in Middle-Aged Adults – the French Constances cohort study.” Submitted at Nicotine and Tobacco Research. October 2023.

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5. Murielle Mary-Krause, Joel José Herranz Bustamante, Mégane Héron, Astrid Juhl Andersen, Tarik El Aarbaoui, and Maria Melchior. 2021. “Impact of COVID-19-like Symptoms on Occurrence of Anxiety/Depression during Lockdown among the French General Population.” *PLoS One* 16 (7):e0255158.
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Poster presentations at international conferences

1. Astrid Juhl Andersen. 2021. Symptoms of anxiety/depression before and during the COVID-19 related lockdown. Poster presentation at The Longitudinal Studies 2021 virtual conference. March 2021.
2. Astrid Juhl Andersen, Murielle Mary-Krause, Joel Bustamante, Tarik El Aarbaoui, Megane Héron, Maria Melchior. 2022. Symptoms of anxiety/depression during the COVID-19 pandemic and associated lockdown in the community: longitudinal data from the TEMPO cohort in France. *European Psychiatry* 65, S132–S132. <https://doi.org/10.1192/j.eurpsy.2022.361>. Poster presentation at the European Congress of Psychiatry, Virtual Conference, June 2022
3. Astrid Juhl Andersen, Maria Melchior, Solene Wallez, Irwin Hecker, Murielle Mary-Krause. 2022. Are we socially equally at risk of smoking during the COVID-19 pandemic? French data from 2009-2021. *European Journal of Public Health* 32. <https://doi.org/10.1093/eurpub/ckac131.080>. Poster presentation at the European Public Health Conference in Berlin, November 2022
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Poster and oral presentations at seminars

1. Astrid Juhl Andersen. 2021. Smoking during the COVID-19 pandemic. Poster presentation at the ED 393 doctoral seminar. November 2021
2. Astrid Juhl Andersen. 2021. Smoking during the COVID-19 pandemic. Oral presentation at the INCa doctoral seminar. November 2021
3. Astrid Juhl Andersen. 2023. Intergenerational Social Mobility and Smoking Trajectories in Middle-Aged Adults and The Mediating Role of Depression. Oral presentation at ERES seminar; February 2023
4. Astrid Juhl Andersen, Murielle Mary-Krause, Maria Melchior. 2023. Socio-professional mobility and smoking trajectories among French middle-aged adults. Poster presentation at the ED 393 doctoral seminar. February 2023
5. Astrid Juhl Andersen. 2023. Intergenerational Social Mobility and Smoking Trajectories in Middle-Aged Adults, Oral presentation at seminar at Section for Social Medicine, University of Copenhagen, March 2023

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List of abbreviations

ASR: Adult Self Report

CI: Confidence interval

COVID-19: Coronavirus Disease 2019

GEE: Generalized estimation equations

INCa: French Institute of Cancer

INSEE: French National Institute of Statistics and Economics Studies

IReSP: French Institute for Public Health Research

NRT: Nicotine Replacement Therapies

OECD: The Organisation for Economic Co-operation and Development

OR: Odds Ratio

SEP: Socioeconomic position

SMD: Standardised mean difference

TEMPO: Trajectoires ÉpidéMiologiques en Population

WHO: World Health Organization

1. Introduction

In 2020, the entire world was disrupted by the COVID-19 pandemic, leading to major changes in everyone's daily lives, due to rapidly implemented sanitary measures such as lockdowns, closure of schools and public and private spaces. Already at the beginning of the pandemic, changes in mental health and health behaviours were highlighted as important factors that could negatively affect public health as consequences of the COVID-19 pandemic (Santé Publique France, 2020). Social isolation is well-known to be associated with poorer in mental health outcomes, including symptoms of depression and anxiety (Leigh-Hunt et al., 2017), so times with restrictions on social gatherings could be expected to have a negative effect on mental health in society. Furthermore, fear of disease and death for oneself or one's relatives can furthermore be a contributing factor to an increase in mental health problems.

Anxiety and depression are found to be associated with increased psychoactive substance use, including both tobacco smoking uptake and frequency (Cougler et al., 2010). This mechanism can be explained by a self-medication model, suggesting that individuals smoke to alleviate psychiatric symptoms (Fluharty et al., 2017). The increased levels of anxiety and depression reported during the pandemic may have affected the otherwise decline in smoking prevalence observed in recent years (Pasquereau et al., 2021). Changes in smoking behaviour were therefore expected during the COVID-19 pandemic, both as a result of dealing with increased levels of anxiety and depression, but also because of the new everyday circumstances, which for most people meant new habits, fear of infection and fewer social gathering. As nicotine is highly addictive, it is important to investigate the changes in tobacco smoking behaviour as early as possible to ensure as few long-term consequences as possible.

To add a more general objective to the thesis in terms of socioeconomic inequalities in smoking behaviour, I furthermore studied the association between intergenerational social mobility and smoking trajectories among mid-life adults including a measurement of smoking status post-COVID-19. This was to get a deeper understanding on what factors do interplay when studying social inequalities in tobacco smoking status. The imbalance in smoking trends has led to a widening gap in smoking between those with high and low education, making smoking an important determinant of social inequalities in health. Although this knowledge is well documented, smoking remains one of the main causes of inequalities in mortality between socio-economic groups, emphasising the importance of continuing to contribute new evidence in this research area.

In this PhD project, I investigated factors that are known to be associated with social inequalities in health during the COVID-19 pandemic. More specifically, I examined the association between pre-existing symptoms of anxiety/depression and symptoms of anxiety/depression during the COVID-19 outbreak. Furthermore, I examined the association between educational attainment and changes in smoking behaviour from 2018 to 2021.

1.1 Aims

The present thesis aims to contribute to the understanding of the vulnerability of individuals with pre-existing mental health problems during the COVID-19 pandemic and changes in smoking behaviour that have occurred throughout the pandemic. This is to get a deeper understanding of factors associated with social inequalities in health in times of a health crisis. The thesis furthermore, will have a broader view, focusing on intergenerational social mobility in smoking status, contributing to knowledge of life-time socio-economic position (SEP) and longitudinal smoking patterns.

I will study this by answering the following three research objectives. The specific research objectives in this dissertation each reflect one article that has been published or submitted after working on the corresponding research objective:

- a. What is the association between pre-existing symptoms of anxiety/depression and symptoms of anxiety/depression during the COVID-19 outbreak among a mid-aged French population?
- b. How did smoking prevalence change from 2009 to 2021 and what is the role of educational level?
- c. What is the relationship between intergenerational social mobility and mid-life smoking trajectories among participants of the French CONSTANCES cohort?

1.2 Brief summary of the research methodology

This PhD project is set in social epidemiology. To study the different aims, we used data from two French cohorts; 1) Trajectoires ÉpidéMiologiques en Population (TEMPO) especially the TEMPO-COVID-19 study, and 2) CONSTANCES cohort.

TEMPO is a longitudinal follow-up study that aims to gain better understanding of the factors associated with mental health and psychoactive substance use, including cigarette smoking patterns. The cohort was initiated in 2009 among young adults aged 22–35 years. These participants had previously participated in a study focused on children's psychological

problems and accessed to mental health care from 1991 to 1999 (Mary-Krause et al., 2021). TEMPO participants were followed via self-completed questionnaires in 2009, 2011, 2015, and 2018. To gather data during the COVID-19 pandemic, the TEMPO-COVID-19 study was conducted between March 2020 and May 2021 and consisted of nine waves of questionnaires sent to all TEMPO participants. During the data collection, the aim was to explore mental health, health behaviour, psychoactive substance consumption, and work conditions during the exceptional context of the global COVID-19 pandemic. A total of 902 participants responded to at least one questionnaire, representing 87% of the 2018 TEMPO respondents. Two overviews of timing of data collection is to be found in Appendix 9.1 TEMPO time line and 9.2 TEMPO-COVID-19 time line.

CONSTANCES is a population-based cohort in France, comprising a substantial number of volunteers who were randomly recruited from 2012 to 2020, where the study successfully enrolled the intended 200 000 participants (Goldberg et al., 2017). Participants were aged 18 to 69 years at the time of inclusion. They were invited to complete self-administered questionnaires focusing on health-related behaviours, occupational conditions, sociodemographic factors, and to undergo a health examination at a Health Screening Center throughout France. Subsequently, participants receive an annual self-administered follow-up questionnaire to complete, using either a paper or online questionnaire.

The work of this PhD started in January 2021, in times where knowledge about changes in anxiety and depression and tobacco smoking during the pandemic were sparse. After the publishing of the two first papers of my PhD, a lot of new research on these specific research areas has been added, and the work must therefore be seen in the light of this. I will go through latest research in the field in the following section, State of Art.

2. State of art

This section provides an overview of existing knowledge on changes in mental health and smoking behaviour during the COVID-19 pandemic. This will be achieved by presenting research on anxiety and depression during the COVID-19 pandemic, followed by an introduction to the smoking epidemic in France as background for the smoking situation in France during the COVID-19 period. Lastly, this section will provide insight in the relationship between intergenerational social mobility and smoking trajectories, which will contribute to an understanding of socio-economic differences in smoking patterns among middle aged adults in France. In this chapter, research objectives of the thesis will be presented in connection with the gaps in existing knowledge that the current thesis aims to address.

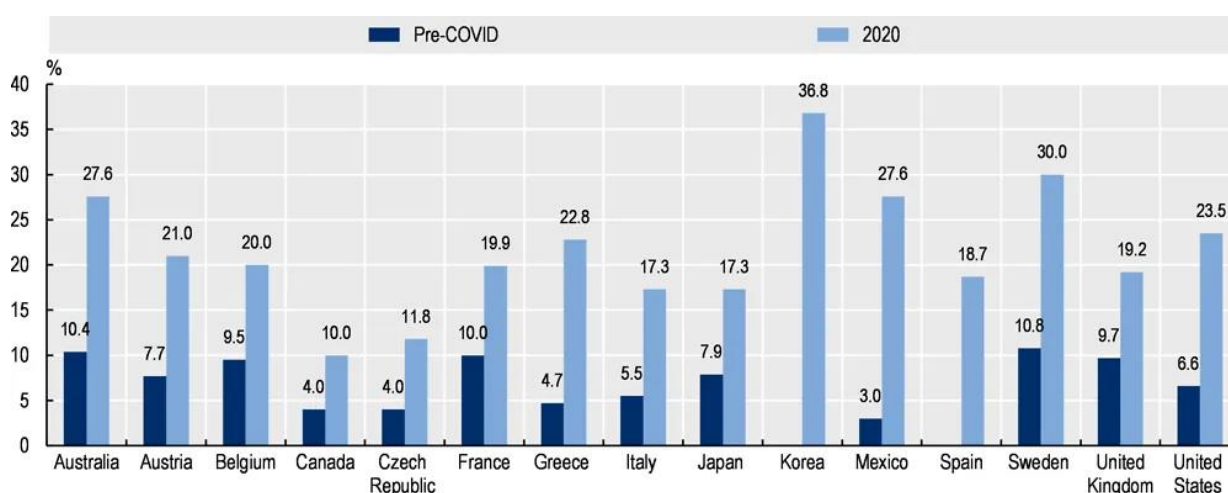
2.1 COVID-19 and related lockdown in France

Starting in February 2020, the world was heavily affected by the global health crisis related to the COVID-19 pandemic, caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which has currently led to more than 6.9 million deaths worldwide (World Health Organization, 2023). To combat the pandemic, the French government, like many other countries, implemented nationwide lockdowns multiple times, starting in March 2020. Throughout these periods, severe restrictions were imposed on social interactions, movement, work, and access to services and healthcare, including limitations on preventive and general medicine services (Delamaire et al., 2021; Topriceanu et al., 2021). The first and strictest nationwide lockdown and home confinement took place from March 17, 2020, to May 11, 2020 (Delamaire et al., 2021). This resulted in nearly two months of stay-at-home orders in France, involving the closure of all pubs, restaurants, cinemas, and nightclubs, as along with the closure of schools and universities. Cafes, restaurants and pubs were allowed to reopen from June 2020, followed by sport centres. Mandatory mask-wearing was required in all public indoor spaces, as well as in some outdoor public areas and workplaces. The second nationwide lockdown was introduced on 28 October 2020, and lasted until December. On 3 April 2021, a third national lockdown was imposed, which included the closure of non-essential stores, suspension of schooling, a ban on domestic travel, and a nationwide curfew from 7PM to 6AM, with restrictions ending at the end of June 2021. The face mask requirement lasted until May 2022 (Gouvernement, 2021).

2.2 Mental health and COVID-19

As a consequence of the severe restrictions imposed during the COVID-19 period and subsequent worldwide lockdowns, there has been an important focus on how changes in social movement, social isolation, economic situation, and fear of infection and mortality would affect people's mental health, both acutely and in the long term. Early in the pandemic, increased levels of anxiety and depression were reported both within France (Santé Publique France, 2020) and internationally (Santomauro et al., 2021; World Health Organization, 2022b). Since the outbreak, French adults seemed to exhibit a notably high prevalence of mental distress, encompassing stress and anxiety, in comparison to other OECD countries (OECD, 2021a). Figure 1 below, published by the OECD in 2021, shows pre-pandemic and post-pandemic measurements of the prevalence of depression or symptoms of depression, revealing substantial increases in all countries. In France, the prevalence increased from 10.0% in 2017 to 19.9% in 2020 (data used from the National Public Health Agency (Santé Publique France)), experiencing a relatively large increase during the period (OECD, 2021a).

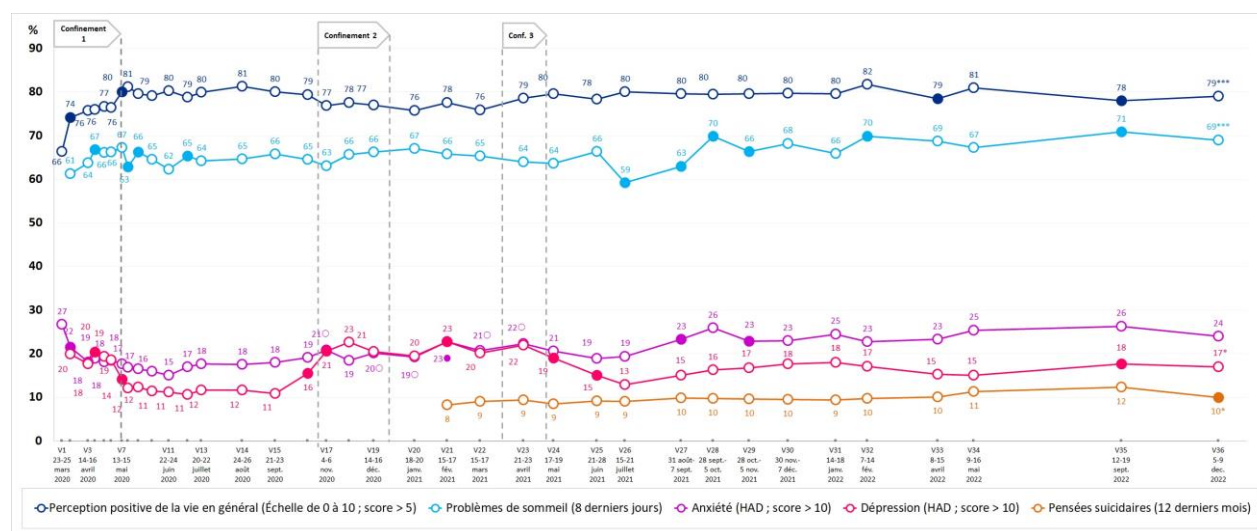
Figure 1: Prevalence of depression increased significantly in 2020. National estimates of prevalence of depression or symptoms of depression in early 2020 and in a year prior to 2020. Figure published in: OECD 2021 Tackling Coronavirus (COVID-19) (OECD, 2021a)



In a national French context, the National Public Health Agency also documented the evolution of mental health indicators from the beginning of the first lockdown and 2.5 years onwards, as shown in the Figure 2 below (Santé Publique France, 2023). By December 2022, 17% of French people exhibited signs of depression (pink line), which corresponds to a significant increase of 7 prevalence points compared to the non-pandemic level (ibid). Regarding anxiety (violet line), 24% of the French population displayed signs of such symptoms, reflecting a very high level with an increase of 11 prevalence points above the non-pandemic level (ibid). Furthermore, the

figure shows that the perception of overall life satisfaction (dark blue line) was at its lowest at the start of the lockdown, and then increasing and stabilizing as time progressed.

Figure 2: Prevalence and trends in mental health indicators and sleep problems (weighted %). CoviPrev survey, metropolitan France, December 2022. Published by Santé Publique France, 2023.



2.2.1 Evidence on mental health and COVID-19

Early in the pandemic, researchers started highlighting the importance of mental health research during the pandemic. Research from previous epidemics had shown that quarantine had a strong impact on mental health (Brooks et al., 2020), and studies conducted within the context of other infectious disease outbreaks have reported that symptoms of anxiety and depression remained elevated both during and several months after the events (Jalloh et al., 2018; Jeong et al., 2016; Wu et al., 2009). In a commentary in *The Lancet Psychiatry* in June 2020, Campion and colleagues highlighted three areas that global public health could face during COVID-19. These areas included a focus on, 1) preventing an increase in mental health problems and a reduction in well-being, 2) protecting people with mental health disorders from COVID-19 and its associated consequences, and 3) providing appropriate public health interventions to healthcare professionals and caregivers (Campion et al., 2020). They highlighted that socioeconomic inequalities, poverty, debt, unemployment, food insecurity, social factors, quarantine, physical distancing, and physical inactivity could serve as factors mediating the pandemic's impact on mental health (Campion et al., 2020). Other explanations for the heightened stress resulting from social isolation during the pandemic included people's ability to work, seek support from loved ones, and engage with their communities (World Health Organization, 2022a).

Furthermore, the feeling of loneliness, fear of infection, suffering and mortality for oneself and loved ones, grief following bereavement, and financial worries have also been identified as stressors leading to anxiety and depression (World Health Organization, 2022a). During the pandemic, services catering for mental, neurological, and substance use conditions were the most disrupted among all essential health services, as reported by WHO Member States, leading to gaps in care for individuals with mental health problems. Many countries also reported major disruptions in life-saving mental health services, including suicide prevention (World Health Organization, 2022a).

The focus on how the pandemic could adversely affect global mental led to the rapid development of numerous research projects aimed at evaluating this impact. Early research, such as descriptive population surveys, suggested an overall increase in prevalence of mental health problems across various populations (Dragioti et al., 2022; Liu et al., 2021; Pierce et al., 2020; Santomauro et al., 2021; Sousa et al., 2021; Wu et al., 2021).

In order to grasp the current state of knowledge, Witteveen and colleagues aimed to provide an overview of the association between the pandemic and common mental disorders, by conducting an umbrella review of evidence (Witteveen et al., 2023). In total, they synthesized 123 systematic reviews with meta-analyses to assess the association between COVID-19 and symptoms of common mental health disorders. Upon summarizing the existing body of knowledge, they found that the few reviews, which pooled longitudinal data, consistently showed a small increase in symptoms of depression and anxiety during the initial stages of the pandemic when compared to pre-pandemic periods among the general population. By including meta-analysis of longitudinal within-person data, they showed that symptoms of depression or mood disorders were increased during pandemic periods compared to pre-pandemic periods (SMC: 0.22, 95% CI 0.13 to 0.30; Hedges' g : 0.16, 95% CI 0.01 to 0.30; representing an increase of 27.6%, 95% CI 25.1 to 30.3), and this elevation persisted over the first half of 2020. During periods of social restrictions, depression symptoms were more pronounced compared to pre-measurements or pre-pandemic periods. Similarly, symptoms of depression during the pandemic showed a significant increase when compared to matched pre-pandemic cross-sectional data. Additionally, anxiety symptoms experienced an elevation during the pandemic in contrast to pre-pandemic data (SMC: 0.40, 95% CI 0.15 to 0.65) (Witteveen et al., 2023). Furthermore, the authors underscored the major limitations within the existing research in this field, which encompass the inability to quantify and explain the high heterogeneity across the included reviews, and the shortage of within-person data from multiple longitudinal studies

(Witteveen et al., 2023). They found that only three of the meta-analyses and reviews fulfilled all critical quality guidelines (as assessed by the Assessment of Multiple Systematic Reviews checklist (AMSTAR 2)). In their umbrella review, Witteveen et al. found an increase in mental health symptoms in people with pre-existing physical conditions, although this phenomenon was not observed in those with pre-existing mental disorders (Witteveen et al., 2023). This observation seems inconsistent with findings suggesting that people with a history of mental health disorders might have greater vulnerability during periods of pandemics (Campion et al., 2020; Holmes et al., 2020; Pierce et al., 2020; Saunders et al., 2021; Vindegaard and Benros, 2020).

A meta-analysis conducted by Sun et al. (Sun et al., 2023), published in 2023, just after the systematic review of Witteveen et al. was therefore not included within their umbrella review. Sun et al. undertook this study with the aim of addressing biases identified in articles concerning mental health and COVID-19. They achieved this by only including longitudinal studies that facilitated a comparison of general mental health, anxiety symptoms, and depression symptoms across the general population and other groups during COVID-19 pandemic, with results from the same cohort prior to this pandemic (Sun et al., 2023). In April 2022, Sun et al. included 137 published studies with longitudinal data and information on pre-pandemic and post-pandemic measures of mental health. The substantial number of articles included underscores the scope of this area of research in a relatively short time. Within the studies involving the general population, they did not find changes in general mental health or anxiety symptoms, and the worsening of depression was minimal ($SMD_{\text{change}}=0.12$, 95% CI 0.01 to 0.24, based on $n=3\,470$ individuals). Concerning general mental health, Sun et al. estimated that the change in the general population cohorts was minimal and not statistically significant ($SMD_{\text{change}}=0.11$, 95% CI -0.00 to 0.22, based on $n=30\,185$). Among various subgroups, they found a small statistically significant worsening of general mental health among female participants ($SMD_{\text{change}}=0.22$, 95% CI 0.08 to 0.35, based on $n=10\,329$). Conversely, symptoms showed slight improvement among people with pre-existing mental health conditions ($SMD_{\text{change}}=-0.22$, 95% CI -0.35 to -0.09, based on $n=457$). For anxiety symptoms, the same trend was observed as for general mental health. The estimated change also increased by minimal to small amounts among female, older adults, university students, and people who self-identified as belonging to a sexual or gender minority group (Sun et al., 2023). Additionally, concerning depression symptoms, there was a marginal improvement for people with pre-existing mental health conditions ($SMD_{\text{change}}=-0.05$, 95% CI -0.08 to -0.03, based on $n=12\,352$).

Results from two earlier and more limited systematic reviews encompassing respectively 65 longitudinal studies (Robinson et al., 2022) and 43 studies (Salanti et al., 2022) from early in the pandemic are in line with these findings, showing that mental health was either unchanged or worsened by minimal to small amount in the general population. One challenge faced by many of the early studies included in the first reviews is the potential for bias, stemming from factors such as their reliance on cross-sectional data without a comparison to pre-COVID-19 pandemic conditions (Sun et al., 2023; Witteveen et al., 2023). Furthermore, a large number of cross-sectional studies have reported proportions of participants scoring above the threshold on easily administered mental health scales. These scores are often considered indicative of the prevalence of mental health problems (Sun et al., 2023). However, these scales are primarily designed for screening purposes and tend to identify a large number of individuals than those with a mental disorder, which leads to an overestimation of the prevalence of mental health problems (Sun et al., 2023).

2.2.2 Research objective 1: Pre-existing mental health and COVID

At the beginning of the thesis work, much of the research presented had not yet been published and little evidence existed concerning mental health during the COVID-19 pandemic. The aim of the first work within this thesis was therefore to contribute to the knowledge about the vulnerability of people with pre-existing mental health symptoms in terms of anxiety/depression symptoms during the first lockdown period, including longitudinal data where we had information on both pre-pandemic and post-pandemic measurements of anxiety/depression symptoms. This leads us to the first research objective of this thesis, which is to investigate the association between pre-existing symptoms of anxiety/depression and the occurrence of such symptoms during the COVID-19 outbreak among middle-aged French adults. The results of this research are presented as the published Article 1 on page 47 of this thesis.

2.3 Tobacco smoking and COVID-19

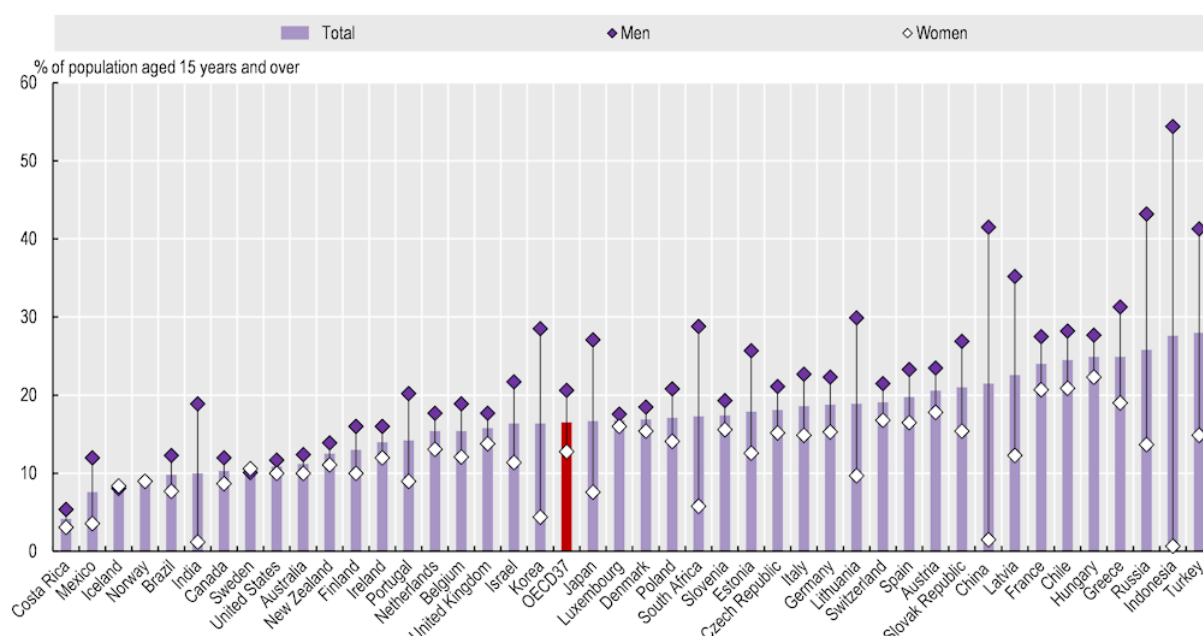
Tobacco smoking is well known to be associated with mental health (Prochaska et al., 2017). In a time when the prevalence of mental health problems is increasing, like during the pandemic, it is therefore interesting to examine concurrent changes in smoking habits. The following section delves into tobacco smoking behaviour. Prior to delving into research on smoking in

the context of COVID-19, this section starts with an overview of historical tobacco smoking rates in France. This is followed by an introduction to social inequalities in smoking prevalence, which will then be used as a background for understanding of the context of smoking behaviour during the COVID-19 pandemic.

2.3.1 Historical smoking rates in France

Despite the well-known fact that smoking is the single most important cause of death, smoking is still widespread and contributes as the largest preventive risk factor to public health (World Health Organization, 2021). Worldwide, an estimated 1.3 billion people use tobacco products, with tobacco-related deaths surpassing 8 million annually (World Health Organization, 2021). Consequently, tobacco smoking ranks among the primary contributors to premature mortality and contributes to one of the biggest public health threats the world has ever faced (ibid). Among the French population, smoking prevalence is high compared to other Western countries. Figure 3, published by OECD Health Statistics in 2021, shows daily smoking across different OECD countries. France is at the high end with a daily smoking rate of 24% of the total population, which is well above the OECD average on 16%, men exhibiting a higher prevalence of smoking compared to women (OECD, 2021b).

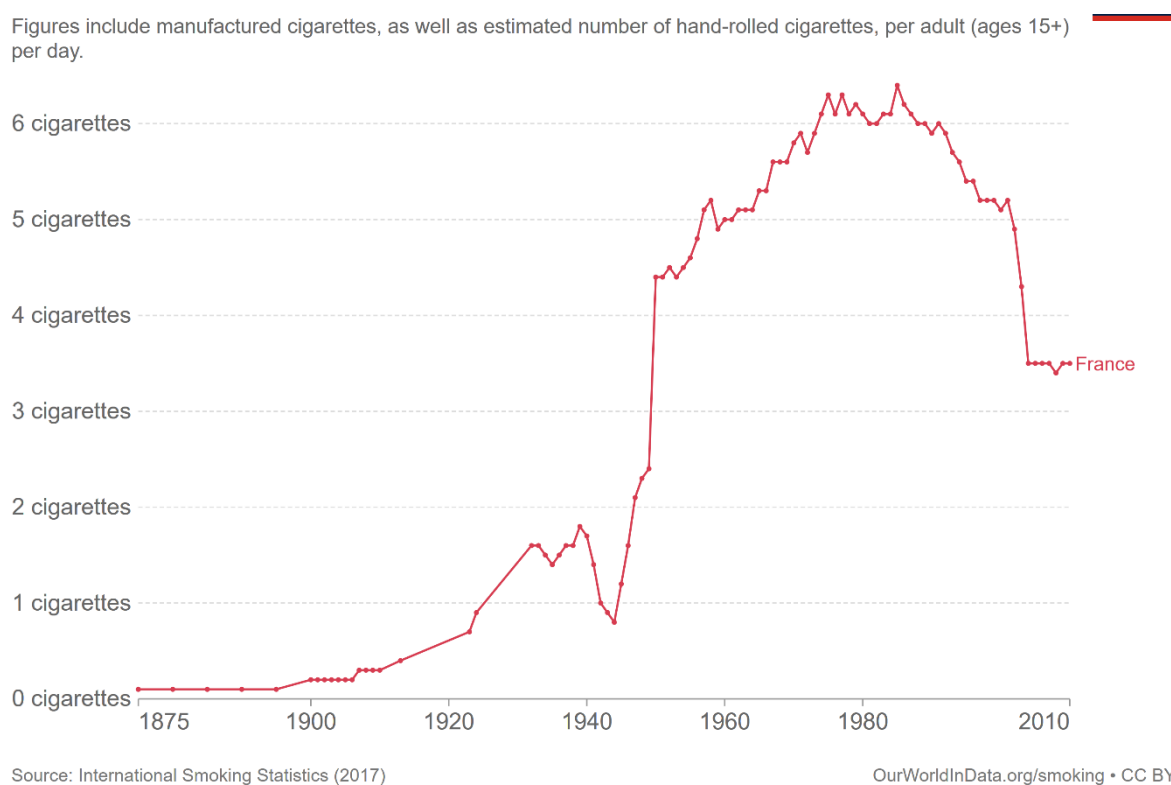
Figure 3: Daily smokers. Total, % of population aged 15+, 2019 or latest available. Source: OECD HealthStatistics. Figure published at: (OECD, 2021b)



When studying the tobacco smoking behaviour among French adults, it is important to understand the historical patterns and trends of tobacco consumption in France. In 1998, Catherine Hill wrote an article on tobacco smoking trends and their health consequences in this

country (Hill, 1998). She showed that there had been a rapid increase in tobacco sales from the inception of the tobacco industry's presence in the French market until 1975, a trend which can also be seen in Figure 4, presented below and published by Our World In Data (Ritchie and Roser, 2013). Sales remained stable between 1975 and 1992, and started decreasing hereafter.

Figure 4: Sales of cigarettes per adult per day in France, 1875 to 2010. Figure include manufactured cigarettes, as well as estimated number of hand-rolled cigarettes, per adult (ages 15+). (Ritchie and Roser, 2013)



Over the decades, France has implemented a number of comprehensive anti-smoking initiatives to combat tobacco use and the health risks associated with it (McNeill et al., 2015). It began with advertising restrictions and the introduction of written labels on cigarette packs from the 1970s to 1990s. In the early 2000s, tobacco sales to minors under the age of 16 were banned and sharp increases in tobacco taxes were introduced. In 2004, France was the first EU country to ratify the World Health Organization's Framework Convention on Tobacco Control (WHO FCTC), which includes a commitment to implement provisions to reduce tobacco-related harm (World Health Organization, 2007). In the same year, French Public Health Law introduced new targets to reduce daily tobacco smoking, focusing on young people and underprivileged populations (McNeill et al., 2015). In 2006, the smoke-free policy was expanded to include enclosed public places in workplaces, shopping centres, airports, train stations, hospitals and schools. In addition, reimbursement on nicotine replacement therapies (NRT) was introduced.

Two years later, the smoke-free policy was further extended to indoors in bars, restaurants, hotels, nightclubs and casinos, with the exception of smoking rooms, which were allowed under strict conditions. In 2009, the sales ban was extended to minors under the age of 18 and a ban on the sale sugar-flavoured cigarettes was introduced. From 2009 to 2013, the second cancer plan was introduced by INCa and included initiatives to reimburse NRT for pregnant women. In 2012, graphic warnings began appearing on roll-your-own packs of tobacco. The third cancer plan and the National Smoking Reduction Program was introduced in 2014 to 2019 and introduces, among other things, standardized packaging, a ban on smoking in cars with children, and increased NRT reimbursement to 65% (Rochoy et al., 2022).

Despite the decline in smoking rates for more than 30 years, this decrease has been unevenly distributed across various demographic subsets. As a result, tobacco consumption continues to pose a substantial public health challenge in France.

Over the years, different subgroups have been especially exposed to smoking and afterwards the health and mortality consequences of tobacco use. Catherine Hill (Hill 1998) especially focused on the widespread sex differences in smoking trends. In 1953, the proportion of regular smokers (at least 1 cigarette pr. day) was 72% among men and 17% among women. For men the prevalence decreased from 72% to 36% between 1953 and 1993, while conversely, it increased from 17% to 23% among women during the same period (Hill 1998). This discrepancy underscores the delayed peak in smoking prevalence among women compared to men. Hill also highlighted, that in 1990, smoking was estimated to have killed about 60,000 people, wherefrom 55,000 of them were men and 2,500 women, indicating that smoking-related deaths accounted for 21% of all male deaths and 1% of all female deaths, reflecting a latency period of about 30 years between the time when a significant proportion of a population starts smoking regularly and the time when the health consequences such as mortality of tobacco smoking become detectable.

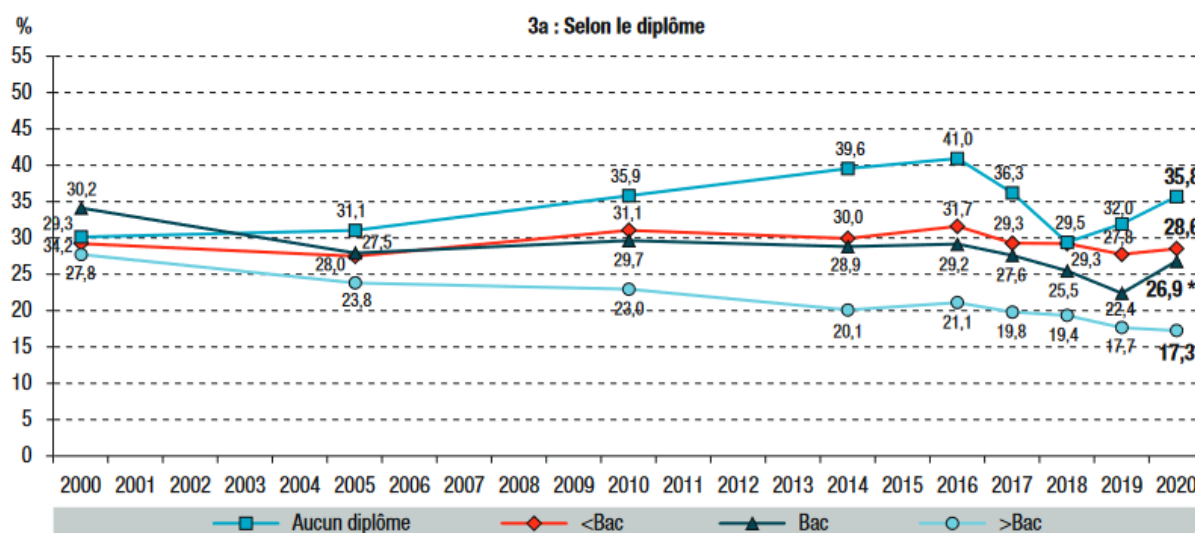
In addition to the gender disparities in tobacco use, differences in smoking rates in relation to education level were highlighted in Hill's article, which still reflects an important factor to consider when studying smoking trends in France. Accordingly to a 1991-1992 survey conducted by INSEE (the French National Institute of Statistics and Economic Studies), it was reported that 40% of men without a high school diploma were smokers, as compared to 31% of men with a high school diploma and 31% of men with an university degree (Hill, 1998). Among women, the corresponding figures were 21% for those without a diploma, 24% for those with a high school diploma, and 23% for those with university degrees. Data shows that already in

the early 1990s, disparities in smoking rates based on educational level existed among men in France. This points to the presence of sex differences in smoking trends with respect to educational level. Among men, there is an inequality in smoking prevalence, whereas for women, the rates are more equally distributed across various educational levels. It is worth noting, however, that due to the delayed onset of smoking patterns among females compared to males, this trend of disproportionate smoking prevalence distribution was expected to emerge among female at a later point in time.

2.3.2 Current development of smoking rates and social inequalities

The disparities in smoking rates linked to educational attainment which Hill highlighted in the late 1990s, have not only persisted but also grown more pronounced in recent decades. In the Western world, smoking rates have generally declined; however, this decline has been significantly faster among people with higher socioeconomic status than among those who are more disadvantaged (Phelan et al., 2010). A report, published by Santé Publique France (French National Public Health Agency) in 2021, based on 10 nationally representative repeated cross-sectional surveys conducted among the French population aged 18 to 75 years, showed the evolution of smoking prevalence according to level of education (Pasquereau et al., 2021).

Figure 5: Prevalence of daily smoking according to level of education (18-75 years) in France, changes in 2000-2020. Figure published in Pasquereau et al., Santé Publique France, 2021¹



¹ Translation in Figure: Selon le diplôme: By degree, Aucun diplôme: No diploma, Bac: Bachelor's degree

Figure 5 shows some of the findings and highlights that the discrepancies in smoking prevalence between people with higher and lower levels of education have widened over the last 20 years. As shown in the figure, in the year 2000, the disparities in smoking rates by diploma corresponded to a 1.5 percentage point difference between those without a diploma and those with a degree higher than bachelor's degree. In 2020, 20 years later, this difference was estimated at 18.5 percentage points, reflecting an increase in smoking prevalence among those without a diploma, alongside a more stable decrease among those with a higher level of education. This trajectory has led to a significant educational gradient in tobacco consumption, resulting in smoking disproportionately affecting low-income communities within high-income countries. Consequently, smoking plays a key role in elucidating health inequalities (Phelan et al., 2010). Research has shown that individuals belonging to lower SEP groups are more likely to experiment with smoking, develop regular smoking habits, and are less likely to quit (Hiscock et al., 2012; Hitchman et al., 2014; Huisman et al., 2005; Song et al., 2009). These factors contribute to the observed unequal disparities in smoking rates. The interplay of mediating factors in the relationship between SEP and smoking will be further elaborated in section 2.4.1 on page 43 of this thesis.

2.3.3 Consequences of differential smoking rates

The disparities in smoking prevalence carry implications for social inequality in both morbidity and mortality. A systematic review conducted in 2018 showed that the median contribution of smoking to the socioeconomic gradient in all-cause mortality ranged from 19% to 32%, highlighting the large contribution of smoking in discussions surrounding socioeconomic inequalities in mortality (Petrovic et al., 2018). Furthermore, the authors showed that smoking accounted for 14% to 22% of the socioeconomic gradient in metabolic disorders and 15% to 17% of cardiovascular disease (ibid.). This emphasizes the importance of ongoing research aimed at comprehending smoking patterns as an essential factor in disease prevention and health promotion – especially during periods when changes in habits were expected. The subsequent section presents research related to changes in smoking habits during the COVID-19 pandemic.

2.3.4 Why would COVID-19 lockdown affect smoking behaviour?

Alongside to how the restrictions put in place to control the spread of COVID-19 would affect mental health, there was a focus on changes in lifestyle habits as a result of the pandemic-related regulations. The increased levels of anxiety and depression reported during the pandemic might have affected the otherwise decline in smoking prevalence. In early stages of the pandemic,

numerous international studies highlighted changes in smoking behaviour. These studies regarding changes in tobacco smoking were grounded in different hypotheses. On one hand, individuals may have reduced tobacco consumption due to the limited social opportunities during lockdown (Bast et al., 2023). Furthermore, fear of infection and illness may have led to a reduction in smoking, as smokers might be more likely to reduce or quit smoking when recognizing the health risks associated with it. This can be explained by the “vulnerability hypothesis”, positing that smokers who are health-conscious are more likely to quit smoking when they understand the health vulnerabilities linked to smoking (Borrelli et al., 2010). Simultaneously, stressors of the pandemic, such as substantial psychological distress (Sarich et al., 2022; Sun et al., 2023) and economic hardships (Pak et al., 2020) could have driven an increase in tobacco consumption as a coping mechanism. Evidence from France and other countries has suggested that smoking behaviour during COVID-19 was affected in different ways, which will be expounded upon in the following paragraph.

2.3.5 Evidence from the COVID-19 pandemic

Several studies have examined the impact of COVID-19 pandemic on smoking behaviour across various countries. Many of these studies have reported diverse behaviours among smokers; for example, a Polish study (Sidor and Rzymiski, 2020) found that up to 45% of adult smokers increased their tobacco consumption, while an Australian study (Stanton et al., 2020) reported a much lower percentage of only 6.9% of adult smokers increasing their tobacco consumption. Other international studies (Bar-Zeev et al., 2021; Carreras et al., 2022; Constant et al., 2020; Cordon et al., 2021; Đogaš et al., 2020; Ferrante et al., 2020; García-Esquinas et al., 2021; Gendall et al., 2021; Giovenco et al., 2021; Glenister et al., 2021; Gravely et al., 2021; Guignard et al., 2021; Klein et al., 2021; Koopmann et al., 2021; Kowitt et al., 2020; Mistry et al., 2021; Reynolds et al., 2021; Tzu-Hsuan Chen, 2020; Vanderbruggen et al., 2020; Vogel et al., 2021; Yingst et al., 2021a; Zhang et al., 2021) have reported varying proportions of smokers increasing their tobacco consumption, while others observed an increase among specific groups and a decrease or no change among others (Bommel   et al., 2020; Gendall et al., 2021; Guignard et al., 2021; Kalkhoran et al., 2022; Siddiqi et al., 2020; Yang and Ma, 2021; Yingst et al., 2021b). Other studies have focused on changes in single outcomes like quit attempts or cessation (Gravely et al., 2021). It is difficult to summarize and compare the results from the available literature due to the varying methodologies employed in different studies and the inadequate reporting of results in some cases. This can account for the difficulty in finding convergent results when examining literature from the early stages of the pandemic.

In a systematic review and meta-analysis conducted in 2022, Sarich and colleagues examined the shifts in tobacco smoking behaviour during the initial pre-vaccination stages of the COVID-19 pandemic and concluded that the results are mixed (Sarich et al., 2022). This holds true not only in terms of the number of people who altered their behaviour, but also in relation to the direction of the change. The following section delves into the factors associated with changes in tobacco use during COVID-19 pandemic.

2.3.5.1 Factors associated with changes in smoking behaviour

Different factors have been identified as associated with increases and decreases in tobacco use during lockdown. In quantitative studies, the main explanatory factors to an increasing change in consumption during lockdown include stress (Carreras et al., 2022; Constant et al., 2020; Giovenco et al., 2021; Klein et al., 2021; Koopmann et al., 2021; Vogel et al., 2021; Yingst et al., 2021a), anxiety (Giovenco et al., 2021; Guignard et al., 2021; Siddiqi et al., 2020), depression (Reynolds et al., 2021; Stanton et al., 2020; Tavalacci et al., 2021), boredom (Giovenco et al., 2021; Yingst et al., 2021a), and younger age (Gonzalez et al., 2021; Guignard et al., 2021; Siddiqi et al., 2020; Vanderbruggen et al., 2020). Other factors contributing to an increase include being female (Glenister et al., 2021; Reynolds et al., 2021), being single (Reynolds et al., 2021; Siddiqi et al., 2020), having lower (Siddiqi et al., 2020) and heavier (Vogel et al., 2021) nicotine dependence, having more time at home to use tobacco (Klein et al., 2021; Yingst et al., 2021a). Conversely, factors associated with a decrease in tobacco use included lower nicotine dependence (Gravelly et al., 2021), general health concerns (Gravelly et al., 2021; Yingst et al., 2021a), spending more time around non-smokers (Yingst et al., 2021a), younger age (Carreras et al., 2022), being an occasional smoker (Carreras et al., 2022), unemployment (Carreras et al., 2022), and experiencing fewer interpersonal interactions (Giovenco et al., 2021). Furthermore, quit attempts might have decreased due to heightened stress coping related to COVID-19 (Rigotti et al., 2021), and immediate declines in serious quitting endeavours were observed among US smokers following the onset of the pandemic (Bandi et al., 2022).

In 2022, Chun et al. published a systematic review including evidence available until January 2021. They included 13 papers into their study, and found that changes in smoking frequency occurred in the early stages of the pandemic. They found that the frequency of smoking either increased or decreased in some cases. Regarding smoking cessation, most cigarette users' intentions and attempts to quit smoking increased, especially among higher average age groups. A greater awareness of the risks associated with contracting COVID-19, a higher level of social

distancing since the start of the pandemic, and an intent to quit smoking were associated with a decrease in tobacco use (Chun et al., 2022). Moreover, they found that corona-phobia increased smoking cessation intentions, and individuals who reduced smoking felt more anxious than those who increased their smoking. However, information regarding whether the included papers were based on longitudinal data was not provided.

Another systematic review, which incorporated longitudinal studies and was published in 2022, included 11 studies, and found that most of the studies pointed out a reduction in the number of cigarettes consumed from before the pandemic to during the pandemic. Only two of the studies reported an increase in cigarette consumption from baseline to follow-up (Almeda and Gómez-Gómez, 2022). A recent meta-analysis, published in 2023 by Bakaloudi and colleagues, included a total of 77 studies, and found that in 34 of these studies, an increase in smoking was reported among the majority of participants. In 21 studies, no significant change was noted, while 18 studies indicated a decrease in smoking as the predominant responses. Their meta-analysis, which examined changes in the number of cigarettes smoked per day, showed no difference between the pre- and post-lockdown periods (Bakaloudi et al., 2023).

2.3.5.2 Socio-economic position and changes in smoking behaviour

While socioeconomic inequalities in smoking rates have been largely documented prior to the pandemic (Hiscock et al., 2012; Hitchman et al., 2014; Huisman et al., 2005), these trends might have been further exacerbated with the COVID-19 pandemic (Pasquereau et al., 2021). Having lower educational attainment or lower income are found as risk factors for higher levels of anxiety and depression at the start of lockdown (Fancourt et al., 2021). The increase in mental health difficulties among disadvantaged groups linked to the COVID-19 might have negatively impacted their smoking behaviours (Jaspal and Breakwell, 2020; Nagasu et al., 2021).

Figure 5 on page 38 also illustrates that smoking prevalence changed differently in 2020 among people with lower education, with prevalence even increasing, compared to those with higher education, who continued to experience a decrease in prevalence (Pasquereau et al., 2021). However, research focusing on SEP differences in changes during the COVID-19 pandemic remains limited, and Sarich et al. highlighted the necessity for subgroup analyses, including examinations of socioeconomic disparities (Sarich et al., 2022).

2.3.6 Research objective 2: Changes in smoking behaviour during the COVID-19 pandemic

Based on the hypothesis regarding changes in smoking patterns, and the need for subgroup analyses, the second research objective of this thesis was to investigate smoking prevalence from 2009 to 2021, focusing on differences between educational levels. Furthermore, we aimed to study the association between changes in smoking behaviour from 2018 to 2021 and levels of educational attainment.

2.4 Social mobility and tobacco smoking

To comprehend our findings, it is important to recognize the interplay of various factors involved in relation to socioeconomic position and smoking status. This section aims to enhance the understanding of socioeconomic differences in smoking prevalence. Firstly, we present established insights into the social gradient in cigarette smoking including a presentation of the interplay of mediating factors on this association. Secondly, this section will include a presentation of current literature concerning intergenerational social mobility and its relation to cigarette smoking.

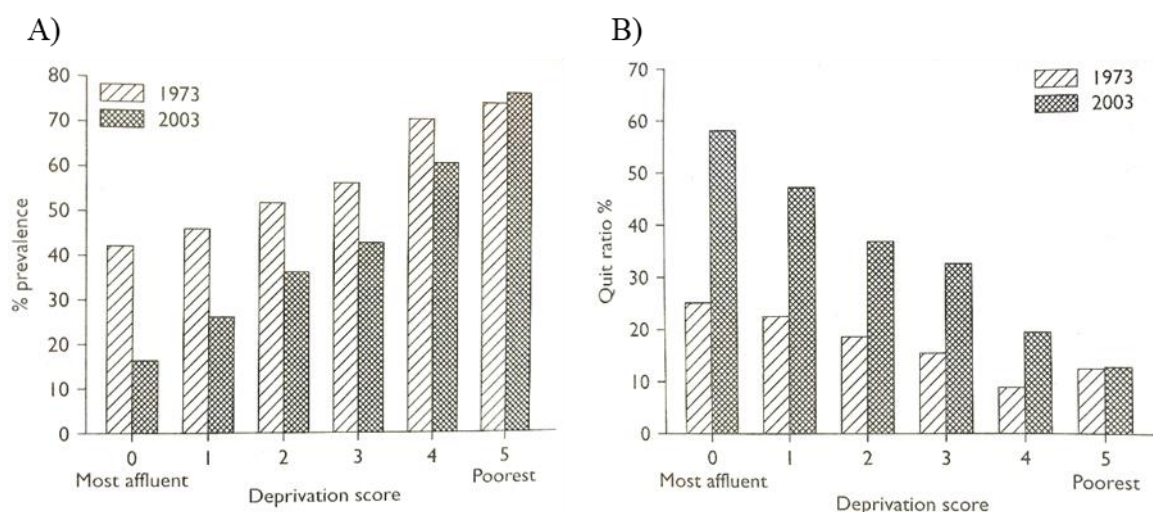
2.4.1 Interplay of factors contributing to the association between SEP and smoking status

Numerous studies have highlighted the social gradient in cigarette smoking, demonstrating that people with lower levels of education and socioeconomic status exhibit higher smoking rates (Hiscock et al., 2012). This trend is not confined to France alone; it holds true on an international scale. Disadvantaged groups, including the long-term unemployed, homeless individuals, those with mental health disorders, single parents, and certain immigrant and ethnic minority populations, display particularly high smoking rates (Hiscock et al., 2012). Furthermore, these groups are more likely to experience negative health effects and increased mortality associated with smoking, with disadvantaged groups being significantly more prone to die from smoking-related causes compared to more privileged smokers (ibid.). Factors that have been identified as predictors of smoking include marital circumstances, cultural deprivation, and indicators of stressful marital, personal, and household situations – namely any marker of disadvantage in Western industrialized societies (Marmot et al., 2005).

In 2005, Michael Marmot and Richard Wilkinson published the second edition of “Social Determinants of Health”, which included a chapter on social patterns in individual health behaviour and the case of cigarette smoking written by Jarvis and Wardle (Marmot et al., 2005). Within this chapter, the authors focused on disparities in smoking rates according to various

indicators of social deprivation. They published the following two figures, Figure 6A and 6B, where smoking rates and smoking cessation ratios are broken down into deprivation score categories and compared in 1973 and 2003. As depicted in Figure 6A, the smoking prevalence is highest among the poorest, demonstrating an approximately linear increase in cigarette smoking with ascending levels of deprivation. It also illustrates that prevalence has decreased by over half from 1973 to 2003 among the most affluent, whereas prevalence among the most deprived has remained the same over the 30 years. One significant contributing factor to this trend is smoking cessation. As shown in Figure 6B, the smoking cessation rate has more than doubled among the most privileged, while the discrepancy in smoking cessation ratios among the poorest group was almost non-existing from 1973 to 2003.

Figure 6: A) Cigarette smoking by deprivation in the UK. Source: General Household Survey 1973 and 2003. B) Cigarette cessation by deprivation in the UK. Source: General Household Survey 1973 and 2003. Figures published in: Marmot et al. 2005, figure 11.1 and figure 11.2



In addition to the notably lower rates of smoking cessation among the most deprived individuals, other factors also contribute to the difference in smoking prevalence and the health consequences of smoking. A gradient in smoking initiation based on deprivation levels is also part of the understanding variations in smoking behaviour (Marmot et al., 2005). Children growing up in poverty often find themselves in households with smoking parents and are exposed to social environments beyond the home where the majority of adults are smokers. Furthermore, evidence indicates a systematic elevation in nicotine dependence with increasing levels of deprivation (ibid.). Poor people achieve higher nicotine intake by both consuming more cigarettes and smoking each cigarette more intensively. Nicotine dependence is an important factor in the ease of quitting, potentially contributing to diminished cessation rates among the most disadvantaged individuals. In addition, given that smoking-related diseases

have a dose-response relationship with nicotine intake, smokers from lower socioeconomic backgrounds face a heightened risk of smoking-related disease compared to their wealthier counterparts. Nicotine intensity is part of the profoundly addictive nature of nicotine, which encompasses various positive rewarding effects that can serve as incentives for cigarette usage. A functional perspective of smoking posits it as a form of self-medication (ibid.), where cigarette smoking is seen as a mechanism to regulate mood, manage stress, and cope with problems and stresses associated with material deprivation, factors that are more prevalent among the most deprived individuals (ibid.).

2.4.2 Intergenerational social mobility and smoking prevalence

The interplay of different factors contributes to the association between socioeconomic position and smoking status, and may be found at different life stages. Research has shown that childhood, adolescence, and young adulthood are crucial periods with regards to health inequalities (Pearce et al., 2019; Viner et al., 2015), wherein individuals from socially disadvantaged backgrounds exhibit higher rates of harmful health behaviours, including tobacco use (Gagné et al., 2020). Factors such as exposure to stressful life events, parental and peer smoking, academic or school difficulties, and socioeconomic disadvantage all contribute to increased risk-taking behaviours such as smoking initiation (Melchior et al., 2007).

The intergenerational transmission of smoking behaviour perpetuates smoking prevalence and inequalities. As previously mentioned, young people growing up in environments with higher smoking rates are more likely to be exposed to smoking behaviour and subsequently experiment with smoking (Badham et al., 2019; Denney et al., 2022). Once addicted, quitting becomes more difficult, leading to higher smoking rates in these populations (Le Foll et al., 2022). Descendants of regular smokers are twice as likely to smoke compared to descendants of non-smokers, emphasizing the intergenerational transmission of tobacco smoking (Melchior et al., 2010). Several longitudinal studies have shed light on the connection between socioeconomic position at various life stages and smoking habits. Such studies have consistently shown that SEP across the life course is associated with smoking status in mid-adulthood (Avila et al., 2022; Tian et al., 2019). Furthermore, the trajectory of family income in childhood has been associated with cigarette smoking in adolescence (Poonawalla et al., 2014). Evidence suggests that grandparents' lower SEP may influence their grandchildren's smoking behaviour, mediated through parental SEP (Doku et al., 2020). However, a German study has shown that the educational level of young individuals, rather than that of their parents, plays a more important

role in smoking risk, with upward educational mobility acting as a protective factor against smoking (Kuntz and Lampert, 2013).

In summary, the complex interplay of socioeconomic factors, intergenerational transmission, and individual educational attainment influence smoking rates and inequalities across different life stages. Understanding these relationships is crucial to addressing the persistent health inequalities associated with smoking behaviour and socioeconomic position.

2.4.3 Research objective 3: Intergenerational social mobility and mid-life smoking trajectories

To understand the association between social mobility and smoking patterns among French adults, the third aim of this PhD was to investigate the association between intergenerational social mobility and mid-life smoking trajectories, using data from the CONSTANCES cohort, a French population-based longitudinally study.

3. Symptoms of anxiety/depression during the COVID-9 pandemic and associated lockdown in the community: longitudinal data from the TEMPO cohort in France

This chapter will present results related to the first aim, which was to investigate the association between pre-existing symptoms of anxiety/depression and the occurrence of such symptoms during the first phase the COVID-19 pandemic. The content of this chapter is drawn from the following publication:

Astrid Juhl Andersen, Murielle Mary-Krause, Joel José Herranz Bustamante, Mégane Héron, Tarik El Aarbaoui, and Maria Melchior. 2021. “Symptoms of Anxiety/Depression during the COVID-19 Pandemic and Associated Lockdown in the Community: Longitudinal Data from the TEMPO Cohort in France.” *BMC Psychiatry* 21 (1): 381. <https://doi.org/10.1186/s12888-021-03383-z>.

3.1 Resume of paper

The COVID-19 pandemic and associated preventive measures are expected to have had an impact on the persons’ mental health, including increasing risk of symptoms of anxiety and depression in particular. Persons with prior mental health difficulties could be an especially vulnerable group, however, few studies have tested this empirically considering pre-existing mental health difficulties.

The objective of this study is to examine the longitudinal association between pre-existing symptoms of anxiety/depression and symptoms of anxiety/depression during lockdown due to the COVID-19 pandemic in a community sample.

Generalized estimation equations models were used to estimate the association between pre-existing symptoms of anxiety/depression and symptoms of anxiety/depression during lockdown among 662 mid-aged individuals from the French TEMPO cohort. Seven waves of data collection were implemented from March-May 2020.

Individuals with symptoms of anxiety/depression prior to lockdown had 6.73 higher odds [95% CI = 4.45–10.17] of symptoms of anxiety/depression during lockdown. The likelihood of symptoms of anxiety/depression during lockdown was elevated among women (OR = 2.07

[95% CI = 1.32–3.25]), subjects with low household income (OR = 2.28 [1.29–4.01]) and persons who reported being lonely (OR = 3.94 [95% CI = 2.47–6.28]).

This study demonstrates a strong relationship between pre-existing symptoms of anxiety/depression and anxiety/depression during the COVID-19 outbreak among mid-aged French adults. The findings underline the role of pre-existing symptoms of anxiety/depression as a vulnerability factor of anxiety/depression during lockdown. Furthermore, the study shows that loneliness is independently associated with symptoms of anxious/depression, when controlling for prior anxiety/depression symptoms.

3.2 Paper published

Andersen et al. *BMC Psychiatry* (2021) 21:381
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BMC Psychiatry

RESEARCH

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Symptoms of anxiety/depression during the COVID-19 pandemic and associated lockdown in the community: longitudinal data from the TEMPO cohort in France



Astrid Juhl Andersen, Murielle Mary-Krause, Joel José Herranz Bustamante, Mégane Héron, Tarik El Aarbaoui and Maria Melchior*

Abstract

Background: To cope with the COVID-19 pandemic, social distancing restrictions were implemented in France, which could have led to social isolation. This is expected to have affected the mental health situation, including increasing risk of symptoms of anxiety and depression in the general population. Persons with prior mental health difficulties could be an especially vulnerable group, however, few studies have tested this empirically considering preexisting mental health difficulties. We examine the association between preexisting symptoms of anxiety/depression and anxiety/depression during lockdown due to the COVID-19 pandemic in a longitudinal community sample.

Methods: A longitudinal follow-up during lockdown (data collection March–June 2020) was implemented among participants of the TEMPO cohort. Prior knowledge of anxiety/depression was included from prior waves of data collection. Generalized estimation equations models were used to estimate the association between preexisting symptoms of anxiety/depression and symptoms of anxiety/depression during lockdown among 662 mid-aged individuals.

Results: Individuals with symptoms of anxiety/depression measured prior to lockdown had 6.73 higher odds [95% CI = 4.45–10.17] of symptoms of anxiety/depression during lockdown. Additionally, the likelihood of symptoms of anxiety/depression during lockdown was elevated among women (OR = 2.07 [95% CI = 1.32–3.25]), subjects with low household income (OR = 2.28 [1.29–4.01]) and persons who reported being lonely (OR = 3.94 [95% CI = 2.47–6.28]).

Conclusions: Our study underlines the role of preexisting symptoms of anxiety/depression as a vulnerability factor of anxiety/depression during lockdown. Interventions focusing on individuals with mental health difficulties as well as people feeling lonely should be considered, to reduce the psychological impact of the COVID-19 pandemic.

Keywords: Mental health, Symptoms of anxiety/depression, Lockdown, Longitudinal study, France

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Background

Since December 2019, the COVID-19 pandemic, caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), and the associated governmental restrictions have impacted daily life in most parts of the world. In France, the government introduced nationwide lockdown and home confinement on March 17, 2020 until May 11, 2020 [1], which stipulated severe restrictions on social contacts, on many people's ability to work, and greatly reduced access to services.

Recent cross-sectional studies have estimated the prevalence of anxiety and depression symptoms during the COVID-19 pandemic in different non-French populations, [2–8] all finding high prevalence of generalized anxiety disorder (GAD) and depressive symptoms after the introduction of the pandemic. Since the COVID-19 outbreak, French adults seem to have an especially high prevalence of mental distress, including stress and anxiety, compared to other OECD countries [9]. Especially people feeling lonely, women, young people, those with preschool aged children, having a low income, or living in cramped housing are identified as especially vulnerable in terms of mental health in the context of the COVID-19 pandemic [4, 10–13]. A recent review has shown that quarantine during previous epidemics had a strong impact on mental health [14], and studies conducted in the context of other infectious disease outbreaks have reported that symptoms of anxiety and depression were elevated during the time of the event and several months after [15–17]. A deterioration in mental health outcomes is expected in the general population during a pandemic and lockdown period [18], but little is known about the impact of these special circumstances on persons with mental health difficulties before lockdown. Yet individuals with preexisting mental health disorders may be one of the particularly vulnerable groups, when it comes to the effects of the lockdown on population mental health [10, 12, 19, 20]. A systematic review investigating the COVID-19 pandemic and mental health, finds that patients with preexisting psychiatric disorders reported worsening in symptoms at the time of lockdown [20].

As in other countries, lockdown in France was associated with an injunction on physical distancing, where it was prohibited to meet with people from other households [1]. During the time of lockdown, loneliness had been considered as an important concern for mental health [21], where loneliness was seen as the main risk factor for depression, anxiety and their comorbidity [22]. Even in times without lockdown, loneliness and mental health difficulties are found to be highly associated [10, 23, 24], while social isolation due to lockdown can be expected to have an impact on the risk of experiencing symptoms of depression and anxiety during lockdown [4, 25].

With the knowledge we have about the mental health situation during lockdown, and groups that appear especially vulnerable, there is reason to believe that persons who experienced symptoms of anxiety/depression before the COVID-19 pandemic are more vulnerable to internalizing symptoms during lockdown than those with no such symptoms experienced earlier. In line with this, the aim of this study is to examine the association between preexisting symptoms of anxiety/depression and symptoms of anxiety/depression during the COVID-19 outbreak among a mid-aged French population. Furthermore, we are interested in examining other factors related to symptoms of anxiety/depression during the first lockdown in France, including sex, household income and loneliness.

Methods

Study population and procedure

This study includes 662 participants from the TEMPO COVID-19 project, a longitudinal follow-up study aiming to better understand French adults' mental health situation during the pandemic. Data was collected seven times starting on the 24th of March 2020, 1 week after France declared lockdown. The TEMPO COVID-19 project is nested within the TEMPO (Trajectoires Épidémiologiques en POPulation) cohort, which has been described in detail elsewhere [26, 27]. Briefly the TEMPO cohort was set up in 2009 among young adults (22–35 years), who had previously taken part in a study on children's psychological problems and access to mental health care in 1991 and 1999 [28, 29]. In 2009, participants from 1991 were contacted to complete the TEMPO study, and were followed via self-completed questionnaires in 2011, 2015 and 2018 [30]. From March to June 2020, TEMPO COVID-19 data were collected in seven periods of time. Invitations and reminders to participate were sent by email to all TEMPO participants with a valid email address, corresponding to a total of 1224 participants contacted at every time. Follow-up questionnaires were sent weekly for the first five data collections, and biweekly for data collections six and seven (for specific dates and number of participants see Supplementary Table 1).

Measures

Outcome: anxious/depressive symptoms during lockdown

Mental health during lockdown was measured using items from the *Anxious/Depressed* syndrome scale based on the Adult Self Report (ASR)-Achenbach System. The ASR is a well-validated instrument to assess adult psychopathology and is used for both clinical and research purposes and includes in total 18 items [31, 32]. Each item is rated on a three-point scale from 0 (*Not true*), 1 (*Somewhat true or Sometimes*) and 2 (*Very Often or Often True*). To calculate scores of symptoms of anxiety

and depression during lockdown, this study includes 8 items in the first follow-up questionnaire in 2020 and 13 items in the questionnaire used for the 2–7 follow up selected from the Anxious/Depressed syndrome scale [33] (for specific questions selected see Supplementary Table 2). In the present study the Anxious/Depressed syndrome scale was dichotomized. To create a comparable anxiety/depression measure across points of follow-up the scores were transformed to a 0–100 scale. According to ASR guidelines, the 85th percentile serves to identify persons with clinically significant symptoms [32]. The values on the 85th percentile for each data collection during COVID-19 were calculated, and the mean of these values resulted in a cut-off corresponding to a score of 34. This score was used to create a comparable dichotomous measure across the seven questionnaires during lockdown.

Preexisting symptoms of anxiety/depression

Information on participants' past symptoms of anxiety and depression was included using the last available measure from prior waves 2018 (87%), 2011 (11%) or 2009 (2%) of the TEMPO cohort. In 2018 participants completed the same items from the ASR Anxious/Depressed syndrome scale as in TEMPO COVID-19 wave 1. For the subgroup that did not complete the 2018 TEMPO study questionnaire, mental health information was used from 2011, where participants reported information on major depression and generalized anxiety disorder subscales of the Mini-International Neuropsychiatric Interview (MINI) [34, 35]. For the remaining subjects with no information on anxiety/depression symptoms from 2018 or 2011, information on anxiety/depression were included from 2009, where participants also answered items from the ASR. If no information were available from those 3 years, subjects were excluded from the analysis.

Covariates

Participants' demographic, occupational, and economic characteristics were collected in the first questionnaire answered during lockdown. Marital status was grouped into 'single, divorced or widowed' vs. 'married or in a civil union.' Living situation was coded as 'living with a partner with children,' 'living with a partner without children' and 'other,' and housing situation as 'living in a house' vs. 'living in an apartment.' Participants' educational attainment was dichotomized based on whether individuals had obtained up to an initial university degree (2 years post high school or less) or a bachelor's degree or higher (at least 3 years post high school). Furthermore, we identified whether participants lived in an area with a high level of COVID-19 infections in March to June 2020, where 'yes' included the Paris

region or Eastern France and 'no' included rest on France [36]. Participants' occupational status was defined by their employment type, which was divided into four groups; 'stable' defined as permanent contract, civil servant, or self-employed, 'unstable' defined as temporary contract or other short-term employment, 'unemployed and looking for a job,' and 'unemployed and not looking for a job.' Self-reported household income was dichotomized based on the best fitting category according to the median income in France (2500 euros or less per month vs. 2501 euros or more per month) [37]. Preexisting financial difficulties were self-reported in 2018 and covering basic necessities (rent, heating or electricity costs, medical care or medication, and eating varied, sufficient and balanced meals). For individuals who did not respond in 2018, we used information on financial difficulties in the 12 months preceding lockdown. In each questionnaire, participants were asked the UCLA (University of California, Los Angeles) 3-item Loneliness Scale [38], where the questions are rated from 1 (*Hardly never*) to 3 (*Often*). Individuals with a summed score from 3 to 5.9 were considered as "not being lonely," and those with a score from 6 to 9 as "lonely" [39].

Statistical analyses

To study the association between symptoms of anxiety/depression during lockdown and the previous measure of anxiety/depression, we started describing the TEMPO COVID-19 sample participants' characteristics and their preexisting mental health situation. Second, we implemented bivariate and multivariate generalized estimation equation (GEE) models, with a logit link and binomial distribution as well as an unstructured correlation matrix, to examine the relationship between the outcome, that is, anxious/depressive symptoms during lockdown, and previous measure of anxiety/depression symptoms and covariates. To control for potential confounders, all covariates with a p -value < .20 in the bivariate GEE model was included. Factors adjusted for in the final model were: sex, living situation, occupational status, household income and measures of loneliness during lockdown. Lastly, interactions between previous measured symptoms of anxiety/depression and covariates were tested. Statistically significant interactions were included in the final model. All analyses were performed using SAS (version 9.4), and are based on a complete case analysis.

Results

In total, 729 individuals participated in at least one of the seven follow-up questionnaires during lockdown, 67 participants were excluded due to missing information, yielding a total sample of 662 subjects with complete data on at least one of the seven study questionnaires. In

most cases (87% [$n = 575$]) information on preexisting mental health difficulties was available in the 2018 TEMPO wave, and for subgroups in 2011 (11% [$n = 76$]) and in 2009 (2% [$n = 11$]). Descriptive statistics are presented in Table 1.

Females represented 64% of study population. Participants were on average 40 years old, a majority were married, living with a partner and children, and working in stable work contract. Furthermore, most participants lived in a house and in a low COVID-19-incidence area (29% were living in the Paris region or Eastern France, where the incidence of COVID-19 was highest in March–June 2020).

Table 2 presents the results of bivariate GEE models, showing that preexisting symptoms of anxiety/depression were associated with significantly higher odds of symptoms of anxiety/depression during lockdown.

Results of the multivariate adjusted model are shown in Table 3.

As hypothesized, a statistically significant association was found between preexisting symptoms of anxiety/depression and such symptoms during lockdown in March–May 2020 in the multivariate GEE analysis. Participants presenting symptoms of anxiety/depression prior to lockdown were about 7 times more likely to report symptoms of anxiety/depression during lockdown. Furthermore, being female, having a low household income and suffering from loneliness were associated with higher odds for symptoms of anxiety/depression during lockdown. A statistically significant interaction was identified between preexisting anxiety/depression and loneliness during lockdown ($p = 0.04$).

Discussion

Summary of findings

The aim of this study is to demonstrate the relationship between prior measured symptoms of anxiety/depression and anxiety/depression during the COVID-19 outbreak among mid-aged French adults. Our study illustrates a strong relationship between symptoms of anxiety/depression measured years before lockdown, and symptoms during lockdown averaged over the study population. Additionally, we found increased odds for symptoms of anxiety/depression during lockdown among women, persons with low household income and those who reported being lonely. Overall, our results point to the continuity in symptoms of anxiety/depression during the course of the COVID-19 pandemic, particularly during the lockdown period in the spring of 2020.

Study strengths and limitations

Our study has several strengths including: a) a longitudinal study design with follow-up during lockdown and

measures of mental health prior to the COVID-19 pandemic, b) a validated measure of symptoms of anxiety/depression, and, c) inclusion of key confounders (e.g. sex, living situation, household income). In addition, symptoms of anxiety/depression were assessed throughout lockdown, reflecting participants' emotional well-being during this period with precision. To consider the fact that social isolation during the time of lockdown could affect the association between preexisting symptoms of anxiety/depression and anxiety/depression during lockdown, we included measures of loneliness in our analysis. Nevertheless, our study also has some limitations. The generalizability of our results is limited by the size and composition of the study sample. TEMPO includes middle-aged adults, a majority of whom work with a stable contract, and have a high household income compared to the general French population. While the sample is diverse enough to compare different groups, the role of preexisting mental health difficulties with regard to well-being during the COVID-19 pandemic may be stronger in the general population. Furthermore, the size of the study population may be limited to identify some associations, particularly interactions between prior symptoms of anxiety/depression and socioeconomic conditions and these should be tested again in larger samples. Finally, information on prior symptoms of anxiety/depression was not available for all subjects in 2018, which lead us to use information collected in 2011 and 2009, possibly inducing information bias. However, supplementary analyses showed that the timing of measurement of prior symptoms of anxiety/depression did not modify our final findings. When dichotomizing the exposure and outcome variables there is a risk of misclassification. However, the use of a validated instrument to measure symptoms of anxiety/depression accommodates this to certain extent, and the dichotomization of the variables in this study is based on previous used methods and after exploring data [40].

Interpretation

Despite these limitations and in line with our main hypothesis, it appears that persons with symptoms of anxiety/depression 2 years preceding lockdown were more vulnerable to internalizing symptoms during COVID-19 related lockdown. This is in line with predictions related to the pandemic [10, 12, 19, 20], and highlights continuity in psychological vulnerability since affective symptoms, such as anxiety and depression, are somewhat stable over time [41–45].

As in other contexts, we found that women were approximately two times more likely to have symptoms of anxiety/depression compared to men during the COVID-19 lockdown period [11, 13, 46, 47]. Many reasons may explain why women are more vulnerable to

Table 1 Socio-demographic characteristics of TEMPO cohort study participants and mental health status prior to COVID-19-related lockdown (March–June 2020)

	Total	Preexisting symptoms of Anxiety/Depression ^c		p-value
	662 (100%)	No 495 (74.8%)	Yes 167 (25.2%)	
Sex ^a				
Male	237 (35.8%)	204 (41.2%)	33 (19.8%)	< 0.0001
Female	425 (64.2%)	291 (58.8%)	134 (80.2%)	
Age ^a				
Mean (SD)	39.8 (3.65)	39.9 (3.70)	39.3 (3.47)	0.3252
Marital status ^a				
Married, or in a civil union	528 (79.8%)	401 (81.0%)	127 (76.0%)	0.1676
Single, divorced or widowed	134 (20.8%)	94 (19.0%)	40 (24.0%)	
Living situation ^a				
Living with partner and children	434 (65.6%)	343 (69.3%)	91 (54.5%)	0.0016
Living with partner without children	70 (10.6%)	44 (8.9%)	26 (15.6%)	
Other	158 (23.9%)	108 (21.8%)	50 (29.9%)	
Housing situation ^a				
In a house	450 (68.0%)	343 (69.3%)	107 (64.1%)	0.2111
In an apartment	212 (32.0%)	152 (30.7%)	60 (35.9%)	
Educational attainment ^a				
Bac + 3 or higher	471 (71.2%)	355 (71.7%)	116 (69.5%)	0.5779
Bac + 2 or lower	191 (28.8%)	140 (28.3%)	51 (30.5%)	
Living area ^a				
Low level of COVID-19 incidence	468 (70.7%)	352 (71.1%)	116 (69.5%)	0.6854
High level of COVID-19 incidence	194 (29.3%)	143 (28.9%)	51 (30.5%)	
Occupational status ^a				
Stable contract type	593 (89.6%)	451 (91.1%)	142 (85.0%)	0.1235
Unstable contract type	31 (4.7%)	20 (4.1%)	11 (6.6%)	
Not working, but looking for a job	24 (3.6%)	14 (2.8%)	10 (6.0%)	
Not working, not looking for a job	14 (2.1%)	10 (2.0%)	4 (2.4%)	
Household income ^a				
2501 euros or more	542 (81.9%)	421 (85.1%)	121 (72.5%)	0.0003
2500 euros or less	120 (18.1%)	74 (14.9%)	46 (27.5%)	
Financial difficulties ^b				
No	587 (88.7%)	449 (90.7%)	138 (82.6%)	0.0044
Yes	75 (11.3%)	46 (9.3%)	29 (17.4%)	
Loneliness ^d				
No	568 (85.8%)	440 (88.9%)	128 (76.6%)	< 0.0001
Yes	94 (14.2%)	55 (11.1%)	39 (23.4%)	

^aMeasured each time a participant answered to TEMPO COVID-19 questionnaires for the first time.^bMeasured 2018 [*n* = 566], or if missing in first wave answered in TEMPO COVID-19 (past 12 month) [*n* = 96].^cMeasured in 2018 [*n* = 575], or if missing in 2011 [*n* = 76] or 2009 [*n* = 11].^dMeasured each time a participant answered to TEMPO COVID-19 questionnaires, and average score was calculated.

internalizing symptoms (including reporting style, personality traits, and hormonal factors) [48–51]. In the general population, women's greater self-regulation and sensitivity to interpersonal concerns increases their

vulnerability to internalizing problems [48–51]. It is also important to note that during the COVID-19 pandemic and associated lockdown, women were largely responsible for home and childcare including school-related

Table 2 Preexisting symptoms of anxiety/depression and covariates in relation to symptoms of anxiety/depression during COVID-19 related lockdown (March–June 2020). Bivariate GEE regression models (Unadjusted Odds Ratios (OR) and 95% Confidence Interval (CI), TEMPO cohort study, $n = 662$)

Symptoms of Anxiety/Depression during COVID-19 lockdown			
	OR	95% CI	p-value
Preexisting symptoms of Anxiety/Depression at least once			
No	1		
Yes	6.74	[4.71–9.65]	< 0.0001
Sex			
Male	1		
Female	2.59	[1.71–3.93]	< 0.0001
Age	0.97	[0.93–1.02]	0.1934
Living situation			
Living with partner and children	1		
Living with partner without children	1.51	[0.84–2.73]	0.1683
Other	1.45	[0.84–2.73]	0.0630
Housing situation			
In a house	1		
In an apartment	0.84	[0.57–1.22]	0.3554
Educational attainment			
Bac + 3 or higher	1		
Bac + 2 or lower	1.28	[0.88–1.86]	0.1979
Living area			
Low level of COVID-19 incidence	1		
High level of COVID-19 incidence	0.78	[0.54–1.17]	0.2531
Occupational status			
Stable contract type	1		
Unstable contract type	0.97	[0.44–2.14]	0.9475
Not working, but looking for a job	3.56	[1.74–7.29]	0.0005
Not working, not looking for a job	1.20	[0.37–3.83]	0.7635
Household income			
2501 euros or more	1		
2500 euros or less	2.67	[1.79–3.99]	< 0.0001
Loneliness			
No	1		
Yes	2.45	[1.91–3.13]	< 0.0001

duties, in addition to their own work responsibilities, which may have resulted in additional sources of stress and contributed to internalizing symptoms during lockdown [52].

Furthermore, we found that people with a household income corresponding to 2500 euros or less were more likely to have symptoms of anxiety/depression during lockdown compared to those with a household income higher than 2501 euros. Many studies have demonstrated the existence of socioeconomic inequalities in

Table 3 Association between preexisting symptoms of anxiety/depression and symptoms of anxiety/depression during the COVID-19 related lockdown (March–June 2020). Multivariate GEE regression model (adjusted Odds-ratios (OR), 95% Confidence Interval (CI), TEMPO cohort study, $n = 662$)

Symptoms of Anxiety/Depression during COVID-19 lockdown			
	OR	95% CI	p-value
Preexisting symptoms of Anxiety/Depression			
No	1		
Yes	6.73	[4.45–10.17]	< 0.0001
Sex			
Male	1		
Female	2.07	[1.32–3.25]	0.0015
Living situation			
Living with partner and children	1		
Living with partner without children	0.73	[0.39–1.36]	0.3208
Other	0.48	[0.22–1.06]	0.0689
Occupational status			
Stable contract type	1		
Unstable contract type	0.58	[0.23–1.46]	0.2441
Not working, but looking for a job	1.92	[0.89–4.16]	0.0972
Not working, not looking for a job	0.85	[0.29–2.52]	0.7714
Household income			
2501 euros or more	1		
2500 euros or less	2.28	[1.29–4.01]	0.0044
Loneliness			
No	1		
Yes	3.94	[2.47–6.28]	< 0.0001

mental health [53, 54], and in general, persons with financial difficulties are at increased risk of mental health problems. Not only can stress related to poverty or financial insecurity lead to mental health problems, they can also worsen preexisting mental health difficulties and inhibit recovery [55]. Previous research in France, has showed inequalities in mental health according to socio-economic position, including household income [56]. Our findings are consistent with these data and suggest the presence of socioeconomic inequalities in mental health during the period of lockdown related to COVID-19 [11].

In line with our predictions, we found that loneliness was associated with participants' symptoms of anxiety/depression. Holmes et al. (2020) describe increased social isolation and loneliness as likely major adverse consequences of the COVID-19 pandemic and related preventive measures, which are both strongly associated with anxiety and depression. Loneliness is common among people with mental health difficulties and predicts worse recovery [23, 24, 57]. It can also be a

symptom of poor mental health. There is a suggestion that persons who experience mental health difficulties have a tenfold increase in the odds of being lonely, compared to the general population [24], and up to 40% of people with depression feel lonely most of the time [58]. Cross-sectional studies conducted in the context of the COVID-19 pandemic estimated loneliness to be a key risk-factor of depression, anxiety and their comorbidity [4, 22, 25]. Additionally, our study underlines that loneliness is independently associated with symptoms of anxiety/depression during lockdown, even when controlling for prior symptoms of anxiety/depression.

Implications

Our study contributes new insight on the continuity in symptoms of anxiety/depression prior to and during lockdown. Combining knowledge from studies estimating a higher prevalence of anxiety and depression and loneliness during lockdown with our data, our results suggests that both persons with preexisting symptoms of anxiety/depression and those feeling lonely are at higher risk of anxiety and depression during the COVID-19 pandemic and associated lockdown. Studies conducted after other infectious outbreaks have reported elevated symptoms of anxiety and depression during the time of the event and present several months after. A study conducted in Sierra Leone 1 year after the Ebola outbreak, found that symptoms of anxiety/depression were common in a national sample of Sierra Leoneans [15], as well as an elevated rate of Severe Acute Respiratory Syndrome (SARS) related PTS symptoms among hospital employees in Beijing was reported during a 3 year follow up after the outbreak [17]. In the context of the Middle East Respiratory Syndrome (MERS), researchers found that persons with a history of psychiatric illness are at risk of experiencing symptoms of anxiety and anger four to 6 months after quarantine release [16]. These findings emphasize that symptoms of anxiety and depression, as other mental health difficulties, where present in the population long time after the outbreak and the quarantine period, where the same trend could be expected in the context of the COVID-19 pandemic, and the time horizon should be considered when implementing health promotion interventions focusing on population mental health after the pandemic.

To date, there is little evidence of effective interventions to limit the mental health impact of the COVID-19 crisis. However, the post-disaster use of mental health services has been shown to be effective. A Korean study conducted after the MERS epidemic found that an active approach, including health professionals contacting persons directly (rather than giving them written information), resulted in a higher rate of mental health service utilization [59]. In Australia, the use of telehealth has

been shown to be effective to treat common mental health disorders, including depression and anxiety, among adults [60, 61], and in times of social distancing tele-mental health services can contribute to reducing psychosocial distress without increasing the risk of infection [62].

Furthermore, a focus on reducing loneliness, which could effectively involve cognitive or educational components [63], might be an important target for prevention programs in order to mitigate negative mental health consequences during the pandemic as well [10, 25].

Conclusion

This study examines the longitudinal effect of prior symptoms of anxiety/depression in the context of the COVID-19 pandemic and associated lockdown, and gives insight into the risk of anxiety/depression during lockdown among a mid-aged French population. The present study contributes to the identification of potential groups at risk for mental health consequences during the COVID-19 pandemic, including anxiety/depression symptoms prior to lockdown, females, people with low household income and lonely subjects. Furthermore, the study shows that loneliness is independently associated with symptoms of anxiety/depression, when controlling for prior anxiety/depression symptoms. As proposed by Campion et al. and the World Health Organization [19, 64], there is need for population-scale implementation of public mental health interventions, and our study suggests a focus on individuals with prior symptoms of anxiety/depression and those feeling lonely. In future research, it would be interesting to focus on the intra-individual changes in mental health before and during lockdown, and investigate related factors, as well as examine the mental health effects of the lockdown after the pandemic.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12888-021-03383-z>.

Additional file 1: Table S1. Date, participant number and symptoms of anxiety/depression in the seven waves of data collection during lockdown due to the COVID-19 pandemic in March–June 2020. **Table S2.** Questions included in mental health variable.

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Authors' contributions

M.M. contributed to the conceptualization and design of the project. J.J.H.B., M.H., M.M.K. and T.E.A. were responsible for investigation and data collection. J.J.H.B. was responsible for data management. A.J.A. contributed to the formal analysis and writing the original manuscript. A.J.A., J.J.H.B., M.H., M.M., M.M.K. and T.E.A. contributed to interpretation of analysis, and reviewing and editing manuscript. All authors contributed to and have approved the final manuscript.

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Availability of data and materials

Due to the personal questions asked in this study, survey respondents were assured that the raw data will be treated confidential and will not be shared.

Declarations

Ethics approval and consent to participate

The TEMPO cohort received approval of bodies supervising ethical data collection in France, the Advisory Committee on the Treatment of Information for Health Research (Comité consultatif sur le traitement de l'information en matière de recherche dans le domaine de la santé, CCTIRS) and the French data protection authority (Commission Nationale de l'Informatique et des Libertés, CNIL). All methods were performed in accordance with the relevant guidelines and regulation. Participants provided informed consent for study participation at registration to the TEMPO cohort.

Consent for publication

Not applicable.

Competing interests

The authors have declared that no competing interests exist.

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4. Are we equally at risk of changing smoking behavior during a public health crisis? Impact of educational level on smoking from the TEMPO cohort

In this following chapter, results of the second objective of the thesis, focusing on smoking behaviour and its relationship with COVID-19, are presented. The chapter is taken from the following publication:

Astrid Juhl Andersen, Irwin Hecker, Solène Wallez, Anke Witteveen, Antonio Lora, Ellenor Mittendorfer-Rutz, Giovanni Corrao, Henrik Walter, Josep Maria Haro, Marit Sijbrandij, Matteo Monzio Compagnoni, Mireia Felez-Nobrega, Raffael Kalisch, Richard Bryant, Maria Melchior & Murielle Mary-Krause. 2023. “Are We Equally at Risk of Changing Smoking Behavior during a Public Health Crisis? Impact of Educational Level on Smoking from the TEMPO Cohort.” *BMC Public Health* 23 (1): 1016.
<https://doi.org/10.1186/s12889-023-15799-1>.

4.1 Resume of paper

Since 2020, the COVID-19 pandemic has greatly affected people including a significant increase in mental health difficulties. Cigarette smoking is found to be strongly associated with mental health conditions, why the pandemic might have influenced the otherwise decline in smoking rates observed over recent years. Persons belonging to socioeconomical disadvantaged groups may be particularly affected, both because the pandemic is found to exacerbate existing social inequalities and because this group was more likely to smoke before the pandemic.

We examined the prevalence of smoking in a French cohort study, focusing on differences between educational attainments. In addition, we examined the association between interpersonal changes in tobacco consumption and diploma from 2018 to 2020, and from 2020 to 2021.

The TEMPO cohort study included 1785 French adults followed between 1991 and 2021. With four assessments of smoking status available before and two after the onset of COVID-19, we estimated the smoking prevalence over time stratified by highest obtained diploma. We studied the interpersonal change in smoking status between 2018 and 2020 among 596 subjects using multinomial logistic regression. Inverse probability weighting was used to account for non-response and logistic regression.

The prevalence of smokers was always higher among those with low educational attainment compared with those with higher diploma. The difference between the two groups increased from 2020 to 2021 (4.8% to 9.4%). Smokers with high educational level were more likely to decrease their tobacco consumption from 2018-2020 compared to lower educated smokers (OR=2.72 [1.26;5.89]).

Current findings showed a widening of the socioeconomic gap over time in relation to smoking rates, which emphasizes the vulnerability of persons with low diploma to smoking, also during the pandemic.

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Are we equally at risk of changing smoking behavior during a public health crisis? Impact of educational level on smoking from the TEMPO cohort

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Abstract

Background The COVID-19 pandemic as a public health crisis has led to a significant increase in mental health difficulties. Smoking is strongly associated with mental health conditions, which is why the pandemic might have influenced the otherwise decline in smoking rates. Persons belonging to socioeconomically disadvantaged groups may be particularly affected, both because the pandemic has exacerbated existing social inequalities and because this group was more likely to smoke before the pandemic. We examined smoking prevalence in a French cohort study, focusing on differences between educational attainment. In addition, we examined the association between interpersonal changes in tobacco consumption and educational level from 2018 to 2021.

Methods Using four assessments of smoking status available from 2009 to 2021, we estimated smoking prevalence over time, stratified by highest educational level in the TEMPO cohort and the difference was tested using χ^2 test. We studied the association between interpersonal change in smoking status between 2018 and 2021 and educational attainment among 148 smokers, using multinomial logistic regression.

Results Smoking prevalence was higher among those with low education. The difference between the two groups increased from 2020 to 2021 (4.8–9.4%, $p < 0.001$). Smokers with high educational level were more likely to decrease their tobacco consumption from 2018 to 2021 compared to low educated smokers (aOR = 2.72 [1.26;5.89]).

Conclusion Current findings showed a widening of the social inequality gap in relation to smoking rates, underscoring the increased vulnerability of persons with low educational level to smoking and the likely inadequate focus on social inequalities in relation to tobacco control policies during the pandemic.

Keywords Tobacco, COVID-19, Smoking behavior, France, Social inequalities

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Introduction

Since 2020, the world has been greatly affected by the global health crisis related to the COVID-19 pandemic. To fight the pandemic, the French government introduced nationwide lockdowns several times from March 2020 onwards. During this period, severe restrictions on social contact, movement, work ability, and access to services and healthcare, particularly preventive and general medicine, were put in place [1, 2], and increased levels of anxiety and depression have been reported both in France and globally [3–5]. Anxiety and depression are found to be associated with increased substance use, including both tobacco smoking uptake and frequency [6, 7], explained by a self-medication model, suggesting that individuals smoke to alleviate psychiatric symptoms [8]. The increased levels of anxiety and depression reported during the pandemic may have affected the otherwise decline in smoking prevalence observed in recent years [9]. Furthermore, fear of infection has been cited as a stressor affecting mental health [10], and perceived risk of complications from COVID-19 related to smoking itself resulted in higher smoking abstinence [11]. Nevertheless, it has been posited that individuals may have increased their smoking behavior as a coping mechanism for psychological distress [12] as well as a consequence of boredom and monotony of lockdown [13]. Concomitantly smoking behavior might have been influenced by environmental factors such as greater availability of smoking opportunities associated with remote work, leading to smoke more freely inside homes, while avoiding the prohibition of smoking indoors at the workplace. In addition, individuals with shorter education were overrepresented in essential jobs during the pandemic that required them to work face-to-face settings [14], which could counteract or even cancel the widening of smoking inequalities during the pandemic. Conversely, some individuals may have decreased smoking behavior as a result of reduced access to tobacco retailers, even if they remained open throughout the lockdown, and fewer social gatherings [15]. It has been found that the length of financial strain during the pandemic was associated with higher change of decreasing smoking intensity [16]. Furthermore, individuals with low socio-economic status were disproportionately impacted by job losses or partial employment during the pandemic, resulting in the loss of some of their income sources due to unstable or supplementary employment [17]. Given the proposed link between smoking and the risk of chronic diseases, including those that serve as risk factors for greater COVID-19 infection severity, it is possible that the pandemic has prompted increased smoking cessation attempts. A recently published systematic review and meta-analysis examining existing literature on tobacco smoking changes during the first pre-vaccination phases of the COVID-19 pandemic reported highly

mixed results [12], including a relative reduction in overall smoking prevalence during the pandemic [12]. Previous studies on smoking in the context of the COVID-19 pandemic have mainly focused on changes in the average number of cigarettes smoked, with some identifying a general increase [18–20], while others observed an increase among some groups and a decrease among others [21–25]. These mixed results may reflect a complex interaction between individual characteristics and structural factors [12], which emphasises the need for subgroups analysis, which may explain the divergent results.

Both mental health and tobacco use have been found to associate with lower educational level. Having lower educational attainment or lower income were found to be risk factors for higher levels of anxiety and depression at the start of lockdown [26], which has been suggested to be associated with increased experiences of hardships such as job losses, reductions in household income, and financial struggles. The increase in mental health difficulties among members of disadvantaged groups linked to the pandemic may have negatively impacted associated smoking patterns [27, 28]. A study based on 10 nationally-representative repeated cross-sectional surveys conducted in France [9] found that people with lower socio-economic position (SEP) showed increased smoking prevalence in 2020 when compared to previous years, while in other groups smoking prevalence rates continued to decrease. A limitation of this study is that the observed differences in prevalence may be due to changes in the study population over time, rather than true differences in prevalence. Longitudinal studies, such as the one conducted in this study, are more appropriate for investigating changes in prevalence.

Given the long-term impact of smoking behavior on the future burden of disease, knowledge of smoking behavior changes during the COVID-19 pandemic among adults is important for tobacco policies and preventive health efforts. In this context, our aim was to investigate smoking prevalence from 2009 to 2021 focusing on differences between educational level. Furthermore, we aimed to study the association between changes in smoking behavior from 2018 to 2021 and educational attainment.

Methods

Setting and study population

This study is based on data from 1785 participants of the French TEMPO cohort. TEMPO is a longitudinal follow-up study that aims to better understand which factors are associated with mental health and substance use, including cigarette smoking patterns. The cohort was set up in 2009 among young adults (22–35 years) who had previously taken part in a study on children's psychological problems and access to mental health care between 1991 and 1999 [29]. TEMPO participants were followed via

self-completed questionnaires in 2009, 2011, 2015, and 2018 [29]. Between March 2020 and April 2021, TEMPO cohort participants completed nine questionnaires aiming to better understand their experience of the COVID-19 pandemic. The first eight questionnaires were sent exclusively by email, and the ninth questionnaire was sent by either email or post. For further detail on the dates of assessment and number of participants, see Supplementary Figure S1.

Measures

Participants' self-reported smoking tobacco status was measured in 2009, 2011, 2015, 2018, 2020 and 2021 (daily, occasional, former smoker or non-smoker) and the average number of cigarettes smoked per day was recorded. The measure of tobacco use for 2020 included participants' smoking status the first time they answered a COVID-19 questionnaire between March and July 2020 (during the first 8 waves of data collection), and the 2021 measure included data collected in wave 9 (collected from December 2020 to May 2021). All participants who reported smoking on average ≥ 1 cigarette per day were considered to be regular smokers [30].

Interpersonal change in cigarette smoking between 2018 (the last available measure before pandemic) and 2021 was measured using participants' smoking status and if smoking, the number of cigarettes smoked in 2018 and in the latest available measurement of smoking status from the TEMPO COVID-19 questionnaire (from here the 2021 measurement) (for the majority from wave 9 ($n=535$), wave 1–7 ($n=147$) and wave 8 ($n=34$)). We compared the individual change from 2018 to 2021 and categorized this into four groups (non-smoker, stable smoker, started or increased smoking, stopped or quit smoking). A 25% or more change in the number of cigarettes smoked daily was considered as a change in behavior, whether increasing or decreasing, to ensure that not only a small change e.g. 1 cigarette per day, would be considered as a change. Sensitivity analyses were performed with 10% and 50% as cut-off.

Educational level was accessed at all follow-ups. Educational level was dichotomized into low (high school level or less (Bac+2 or lower)) vs. high (higher than high school (Bac+3 or higher)). Other sociodemographic characteristics included participants': *sex*, *age*, *symptoms of anxiety/depression* (using items from the Anxious/Depressed syndrome scale based on the Adult Self Report (ASR)-Achenbach System [31]) (yes, no), *household income in 2020* (≤ 2.500 €, ≥ 2.501 €), *working situation in 2020* (employed and normal work situation or working from home vs. unemployed, forced leave, loss of job, or sick leave) and whether or not they were living with a partner (yes, no),

Statistical analysis

The prevalence of smoking was estimated at each time point from 2009 to 2021, stratified based on participants' level of education (low vs. high) and weighted for non-response probability. The difference in smoking prevalence across educational level at each time point was tested using chi-square. T-tests were used to compare the difference of the prevalence of daily smoking between the two educational level groups in 2020 and 2021. To study the association between interpersonal changes in tobacco use from 2018 to 2021 and educational level, we used multinomial logistic regression with the outcome categories (1) stable smoker (reference) (2) increased or initiated smoking or (3) decreased or had quit smoking. We examined factors associated with changes in smoking behavior, and adjusted for those associated with a change by a significance level $p < 0.2$, including sex, age, living in a couple and symptoms of anxiety/depression. Furthermore, we examined the mean of number of cigarettes, and the absolute and percentage change from 2018 to 2021, in the two educational level groups. To account for differential attrition, non-response weights were calculated using Inverse Probability Weighting (IPW) [32, 33] including socio-demographic factors (including sex, education level, living in a couple, symptoms of anxiety or depression and alcohol use from 2009 onwards), and subsequently applied to all further analyses. For all statistical tests, a significance level $p < 0.05$ was used. Besides sensitivity analyses on the interpersonal change in cigarette smoking using a 10% and 50% cut-off in change in number of cigarettes, prevalence estimates were performed using a different cut-off for educational attainment (less than high school (baccalaureate or less) vs. high school or more (Bac+2)). Analyses were performed using SAS Software, version 9.4 (SAS Institute, North Carolina, US).

Results

In total, 1785 participants were included in analyses, with respectively: 1036 participants in 2009, 1211 in 2011, 753 in 2015, 837 in 2018, 696 in 2020 and 603 in 2021. Participants with missing information on smoking status at all time points ($n=18$) or missing information on the covariates used to calculate the non-response weight ($n=52$) were excluded. To study the interpersonal change from 2018 to 2021, 716 participants were included, of which 148 were smokers and thus included in the multinomial logistic regression (see Supplementary Figure S2 for STROBE diagram). The study population were mostly female (62%), averaged 40 years old, and had a higher educational level (72% completed high school or above) than the general French population [29]. Table 1 shows the sociodemographic characteristics of the 716 participants included in analyses on the interpersonal change from 2018 to 2021, and shows that participants with

Table 1 Sociodemographic characteristics of the study population who answered in 2018 and to TEMPO COVID-19 (n = 716)

		Total n = 716	Highest educational level*		Chi ² p-value
			Bac + 3 or more n = 515	Bac + 2 or less n = 201	
Change in smoking situation	Non-smokers	568 (76.4%)	78.2% [74.5;82.0]	72.5% [65.8;79.1]	0.0487
	Stable smokers	33 (5.8%)	4.0% [2.1;5.9]	9.7% [5.1;14.3]	
	Initiated/Increased smoking	63 (9.8%)	9.4% [6.7;12.1]	10.5% [5.9;15.1]	
	Quit/Decreased smoking	52 (8.0%)	8.3% [5.8;10.9]	7.4% [3.6;11.2]	
Sex	Male	249 (37.7%)	37.1% [32.8;41.4]	38.9% [31.8;46.0]	0.6688
	Female	467 (62.3%)	62.9% [58.6;67.2]	61.1% [54.0;68.2]	
Age (years)	Mean (SD)	40.0 (3.62)	39.7[39.4;40.0]	40.5[40.0;41.0]	0.0086
Living in a couple (m*=5)	Yes	565 (78.3%)	78.3% [74.6;82.0]	78.4% [72.5;84.4]	0.9716
	No	146 (21.6%)	21.7% [18.0;25.4]	21.6% [15.6;27.5]	
Symptoms of anxiety/depression in 2020	No	585 (80.6%)	82.0% [78.6;85.5]	77.3% [71.2;83.5]	0.1702
	Yes	131 (19.4%)	17.9% [14.5;21.4]	22.7% [16.5;28.8]	
Household income in 2021 (m*=16)	≤ 2.500 €	129 (20.0%)	13.0% [9.7;16.0]	35.4% [28.4;42.3]	< 0.0001
	≥ 2.501 €	571 (80.0%)	87.0% [84.0;90.0]	64.6% [57.7;71.6]	
Working situation in 2020 (m*=31)	Work normally or from home	497 (71.4%)	78.6 [74.8;82.3]	56.2 [49.0;63.4]	< 0.0001
	Unemployment, forced leave, loss of job, sick leave, maternal/paternal leave	188 (28.6%)	21.4 [17.7;25.2]	43.8 [36.6;51.0]	

*m for number of missing values

Prevalence are weighted for non-response

lower level education were more likely to be stable smokers during the pandemic, whilst participants from the high educational level group were more commonly non-smokers. Furthermore, lower educated participants were more likely to be unemployed, or taking either forced

leave, sick leave and maternal/paternal leave during the pandemic.

In Fig. 1, the smoking prevalence rates between 2009 and 2021 for individuals with low and high educational attainment are depicted. Except for the year 2015 and 2020, the prevalence of daily smoking was consistently higher among those with low educational attainment compared to those with high educational attainment across all time points (chi² p-values; 2009=<0.0001, 2011=<0.0001, 2015=0.0523, 2018=0.0322, 2020=0.2597 and 2021=0.0093). The smoking prevalence estimates for the lower educational group were stable from 2018 to 2021, whereas the prevalence changed more among participants in the higher educated group. Thus, the gap in smoking prevalence between the two groups increased from 2020 to 2021, going from a difference of 4.0% points to 9.4% points (p<0.001).

Besides showing an increased prevalence of smoking, participants with lower educational attainment also smoked more cigarettes per day in 2021 than the high educational level group (12.6 vs. 7.90 cigarettes per day, respectively (p=0.053)).

Table 2 shows results from the unadjusted and adjusted multinomial logistic regression. We found that, between 2018 and 2021, smokers with high educational attainment had higher odds of decreasing their cigarette consumption, as opposed to staying stable, when compared to the less educated population (aOR=2.72 [1.26;5.89]). Thus, people with a higher level of educational showed an increased risk of changing their consumption during the COVID-19 pandemic, compared to people with lower educational level. Furthermore, age was found to be negatively associated with increasing smoking (aOR=0.87 [0.78;0.97]), meaning that older participants showed lower odds of increased smoking behaviour (as opposed to staying stable) when compared to younger participants.

In the sensitivity analysis, in which we used a 10% and 50% cut-off for interpersonal change, respectively, we found similar estimates with a stronger association when using a 10% cut-off and weaker and statistically non-significant association using the 50% cut-off (Table S1 and S2). In the sensitivity analysis using a lower cut-off for educational level, we found similar trends in smoking prevalences, with a higher prevalence among those less educated and a larger difference between the two groups. We did not identify any significant difference in the absolute (p=0.4358) or percentage (p=0.2346) changes of daily cigarettes smoked from 2018 to 2021 between the two educational level groups.

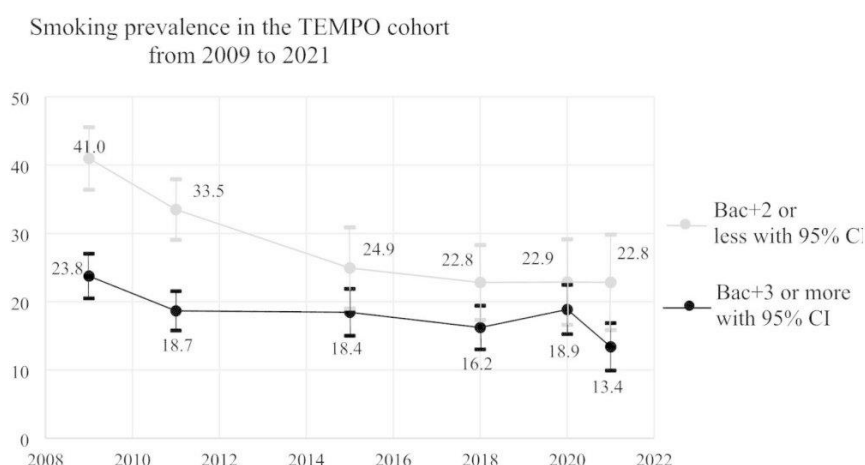


Fig. 1 Smoking prevalence stratified by educational level (Bac + 3 or higher vs. Bac + 2 or less)

Table 2 Multinomial logistic regression model. Unadjusted and adjusted odds ratio (OR) of increased smoking or decreased smoking between 2018 and 2021 vs. being a stable smoker (n = 148), with 95% confidence interval (CI)

Educational level	Unadjusted				Adjusted model			
	Increased vs. stable smoking OR [95% CI]	p-value	Decreased vs. stable smoking OR [95% CI]	p-value	Increased vs. stable smoking OR [95% CI]	p-value	Decreased vs. stable smoking OR [95% CI]	p-value
≥ Bac + 3	2.18 [1.06; 4.49]	0.0346	2.75 [1.28; 5.93]	0.0097	1.94 [0.92; 4.09]	0.0822	2.72 [1.26; 5.89]	0.0108
≤ Bac + 2	Reference		Reference		Reference		Reference	

Model is IPW for non-response, and adjusted for: sex, age, living in couple, and anxiety/depression symptoms

Discussion

Summary of findings

Using data from a longitudinal cohort study that included pre-pandemic data as well as data collected during the COVID-19 pandemic, we found that, the prevalence of smokers was higher among people with low educational attainment compared to those with high. The gap between smoking prevalence across educational groups increased significantly between 2020 and 2021; The prevalence for those in the lower education group remaining stable from 2018 to 2021 whereas that of people with high educational level decreased. To our knowledge, this is the first study to examine longitudinal changes in smoking prevalence in the context of the COVID-19 pandemic, taking into account individuals' educational attainment. Indeed, smokers with high educational attainment were more than twice as likely to decrease their smoking behavior compared to those with lower educational attainment.

Study limitations and strengths

The interpretation of our results needs to be considered in light of several possible limitations. First, the size and composition of the study sample, which was primarily

female, highly educated, and with a higher household income than the general French population [34], limit the generalizability of our results. However, the use of IPW to account for non-response is likely to have decreased the risk of selection bias. While the sample gives the study enough power to compare two education groups, the prevalence of smoking among persons belonging to the low education group is likely to be higher in the general population, as our cohort is not representative due to the participant selection [29]. Second, as no data was collected between 2018 and the onset of the COVID-19 pandemic, any changes during this period were not accounted for. However, the prevalence of tobacco smoking in this age group typically remains relatively stable under normal circumstances [35]. Due to the limited number of smokers that participated both in 2018 and after the onset of the COVID-19 pandemic (n=148), we were not able to include measures for both 2020 and 2021 regarding the interpersonal change analysis. It would have been interesting to focus on 2020 to 2021 in terms of the timing of the increase and decrease in smoking behaviors in the two educational level groups, since our results indicates that the timing of data collection after onset of the pandemic has an impact on what is observed.

Moreover, our study evaluates only cigarette smoking and not tobacco smoking, which could have resulted in an underestimation of the actual level of tobacco use. Nevertheless, cigarettes (either pre-rolled or roll-your-own tobacco) are the most frequently used tobacco product in France, as in other countries [36], so the underestimation of use is likely to be minor. A broader assessment of the types of tobacco products that can be used (e.g. cigars, pipes, e-cigarettes), would have probably yielded larger estimates of socioeconomic inequalities in this area, as people with lower educational attainment are more likely to use non-cigarette tobacco products [25, 37, 38]. Despite these limitations, our study has several strengths which need to be highlighted. First, we used longitudinal data from the French TEMPO cohort, a community sample of young and middle-aged participants with information from 2009 to 2021, thereby limiting the recall bias observed in cross-sectional studies. TEMPO COVID-19 questionnaires were sent out 9 times during 2020 and 2021, enabling the possibility to account for multiple changes with regard to the COVID-19 pandemic, from both the beginning of the pandemic to one year after its onset.

Interpretation

Our findings must be seen in the context of existing studies on smoking during the COVID-19 pandemic, where mixed results have been reported. Indeed, the meta-analysis from Sarich et al. (2022) [12] highlighted the divergent results from previous studies aiming to study changes in tobacco smoking before and during the COVID-19 pandemic. As highlighted in the meta-analysis, few studies have looked at changes by educational level. A nationally representative, repeated cross-sectional study in the French general population [9], found that the difference in smoking prevalence between the lower and higher educational attainment groups did increase from 2019 to 2020. This was due to an increase among people with no diploma or a high school diploma, whereas the smoking prevalence remained stable among both higher and lower educated people. However, their results also indicated that the decline in smoking levels observed the last few years was halted by the COVID-19 pandemic among persons with lower educational attainment, which reflects that socioeconomic inequalities with regard to smoking increased between 2020 and 2021. As including anxiety/depression in the multinomial logistic regression model did not impact the odds-ratio of the educational level on smoking behavior, the association could be explained by other factors. Different factors may contribute to the explanation of the changes of the results. People with shorter educational attainment were found to be more likely to lose their job and to experience decrease in household incomes, which both are found to

be associated with tobacco smoking. This can contribute to the explanation, that people with lower educational attainment were less likely to quit smoking from 2018 to 2020. On the other side, financial difficulties are found to be associated with higher quitting rates of smoking, and as financial difficulties are found to have affected those from low SEP the most during the pandemic. Unemployment has been found to be associated with greater risk for increase in tobacco use [39], which is in line with our findings and can be explained by individuals who were unemployed faced greater stress as a result of the pandemic.

Another study reported an increase in tobacco consumption in the first two weeks of lockdown in France [22], particularly among individuals' aged 18–34 years, those with a high level of education, and those experiencing symptoms of anxiety. Importantly, this study was based on a self-evaluation of changes in smoking behavior, including questions about persons own perception of changes in smoking behavior, thus potentially not matching actual levels of tobacco consumption [40]. The divergent results according to changes in smoking behavior may also result from the timing of the data collections, as we observed that the prevalence of smoking increased among those higher educated, but then decreased over time. This otherwise decline was not observed among those less educated, where a stable prevalence was observed from 2018 to 2021. The preventive measures introduced to limit the outbreak of COVID-19 were stressful, and the economic and financial impact of the pandemic has been found to be greatest among persons from low SEP [41]. Similarly, levels of anxiety and depression have been found to be highest among individuals with lower household income [26, 42, 43], which both associate with higher levels of smoking [7]. Before the pandemic, socioeconomically disadvantaged smokers were less likely to quit smoking, and successful attempts to quit consisted of a higher number of attempts [44, 45]. In terms of smoking cessation, life stress has been shown to impede attempts to quit smoking, in which smoking is seen to provide comfort and help cope with the stress [45]. The stress of the COVID-19 pandemic may have led to an increased exposure to both the risk factors of cigarette smoking, as well as hindrances towards quitting smoking, especially among individuals from low SEP. This group were both subjected to a higher risk of income loss, if their working hours were cut or loss of job, and also infection if they continued to work during the pre-vaccine period of COVID-19 [46]. Results from previous disease epidemics also showed that healthcare and social care professionals were at greater risk of developing short- and long-term mental health problems [47]. These societal factors contribute to the explanation of our results, where an increase was observed among smokers

with higher educational attainment from 2018 to 2020, but 9–14 months after the onset on lockdown they then decreased their rate of smoking again. However, this trend was not observed among those with lower educational attainment, for which the smoking prevalence remained stable. Furthermore, lower educated smokers smoked on average more cigarettes than smokers with higher education.

Implications

Examining how educational levels may influence tobacco smoking in context of the COVID-19 pandemic is a critical issue to address, since identifying groups who are most at risk of changing their smoking behavior can inform public health policies. It is important to identify both vulnerable groups and the factors associated with smoking prevalence, since the harms of tobacco use varies according to SEP. Not only is the incidence of disease, disability, and premature death higher among people with low SEP, but disadvantaged smokers are also at increased risk of dying from smoking, with tobacco responsible for about half of the socioeconomic-related differences in death rates among persons aged 35 to 69 [45]. Furthermore, research also indicates that smoking has an impact on the long-term labour outcome, indicating that smokers have lower income than non-smokers [48], which underlines a two-way causal effect between smoking and SEP, and the importance of preventive measures on tobacco smoking. Specific social and health policies are needed to decrease the socioeconomic gap in smoking behavior, particularly in the context of an epidemic crisis. Smoking cessation interventions, including individual-level approaches, have been shown to be effective for persons from both low and high SEP [49]. However, persons from more disadvantaged groups are still less likely to successfully quit smoking, even though they are just as likely to try to stop [45]. In France, smoking cessation advice from health care providers is well known to be associated with increased quitting [50], but during periods of the COVID-19 pandemic, where access to preventive and general medicine were limited, this path to smoking cessation was also limited.

Conclusion

This study provides important evidence indicating an increased gap between smoking prevalence between educational attainment groups, during a pandemic period. These findings are important from a public health perspective, as changes in the populations smoking patterns following the COVID-19 pandemic may become habitual and persist after lockdowns have ceased. However, a longitudinal investigation is needed to provide more information about the impact of changes over time, especially to observe whether smoking behaviours during the

COVID-19 pandemic will persist beyond the pandemic or will be only transitory. It is important to consider that “even small deviations from unstable steady state consumption can lead to large cumulative rises over time in addictive consumption or to rapid falls in consumption to abstinence” [51]. Given that tobacco smoking is a habit-forming behavior, changes during the pandemic, including a potential rise in smoking, are predicted to persist since quitting smoking has low success rates, particularly among individuals with lower SEP [45].

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-023-15799-1>.

Supplementary Material 1

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Author contributions

M.M., M.M.K. and A.J.A. contributed to the conceptualization and design of the project. M.M.K. were responsible for the investigation and data collection. A.J.A. was responsible for the formal analysis and writing the original manuscript under supervision of M.M. and M.M.K. A.J.A., I.H., M.M., M.M.K. and S.W. contributed to interpretation of analysis. A.J.A., A.L., A.W., E.M.R., G.C., H.W., I.H., J.M.H., M.F.N., M.M., M.M.C., M.M.K., M.S., R.B., R.K. and S.W. and reviewing and editing the manuscript. All authors read and approved the final manuscript.

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Data Availability

Due to the personal questions asked in this study, research participants were guaranteed that all raw data will remain confidential. On reasonable request including standards for General Data Protection Regulation data can be accessed, please send an email to cohort.tempo@inserm.fr. Anonymized data can only be shared after explicit approval of the French national committee for data protection for approval (Commission Nationale de l'Informatique et des Libertés, CNIL).

Declarations

Competing interests

The authors declare that they have no competing interests.

Ethics approval and consent to participate

The TEMPO cohort received approval of bodies supervising ethical data collection in France, the Advisory Committee on the Treatment of Information for Health Research (Comité consultatif sur le traitement de l'information en matière de recherche dans le domaine de la santé, CCTIRS) and the French data protection authority (Commission Nationale de l'Informatique et des

Libertés, CNIL). All methods were performed in accordance with the relevant guidelines and regulation. Participants provided informed consent for study participation at registration to the TEMPO cohort.

Consent for publication

Not applicable.

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5. Smoking status trajectories, intergenerational socioeconomic mobility and depression: Preliminary results from 107,734 French adults (18 to 75 years) of the CONSTANCES cohort

This chapter is extracted from the following paper, which was submitted in Tobacco and Nicotine Research by October 2023.

5.1 Resume of paper

Tobacco smoking remains a significant public health concern despite being a well-established cause of cancer. The prevalence of smoking is disproportionately high in low-income communities in high-income countries due to higher initiation rates and lower cessation rates. Intergenerational social mobility (ISM), which is the relationship between the socio-economic status of parents and the status of their children, has been found to impact smoking in adolescence. However, the relationship between ISM and smoking trajectories in midlife remains understudied.

To address this gap, the present study aims to examine the relationship between Intergenerational Social Mobility (ISM) and smoking trajectories in midlife using data from the CONSTANCES cohort, a representative sample of the French general population.

Including 163,664 participants, Group-Based Trajectory Modelling (GBTM) was used to identify smoking status groups. Multinomial logistic regression analysis was then conducted to estimate the association between ISM and smoking trajectories, accounting for potential common confounding factors. Multiple imputation was used to account for missing data.

Three smoking trajectory groups were identified: non- or former smoking (75.4%), quitting smoking (15.3%) and long-term smoking (9.3%). The results showed that upward mobility was associated with decreased odds of long-term smoking compared to those with persistent high/intermediate mobility (aOR=0.91 [0.87;0.95]), while downward mobility or persistent low mobility was associated with increased odds of long-term smoking (aOR=1.43 [1.38;1.49] and aOR=1.55 [1.49;1.61], respectively). Furthermore, both upward mobility and persistent low were associated with lower odds of quitting smoking during the study period (aOR=0.81 [0.76;0.85] and aOR=0.89 [0.85;0.94], respectively).

The study highlights the impact of intergenerational social mobility on smoking trajectories in midlife. Upward mobility is associated with a decreased risk of long-term smoking, while

downward mobility or persistent low mobility increases this risk. Efforts to improve intergenerational social mobility may have a positive impact on smoking behaviour and reduce the burden of tobacco-related diseases.

5.2 Paper submitted

Intergenerational Social Mobility and Smoking Trajectories in Middle-Aged Adults – the French Constances cohort study

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Abstract

Despite being a well-known cause of cancer and other preventable diseases, tobacco smoking continues to be a major public health concern, particularly in low-income groups. Intergenerational social mobility (ISM), which is the relationship between the socio-economic status of parents and the status of their children, has been found to impact smoking in adolescence. However, the relationship between ISM and smoking trajectories in midlife remains understudied. To address this, the present study aims to examine the relationship between ISM and smoking trajectories in midlife using data from the French population-based CONSTANCES cohort. By using Group-Based Trajectory Modelling including 163,664 participants, the analysis identified three groups of smoking patterns from 2012-2020; non- or former smoking (75.4%), quitting smoking (9.3%) and long-term smoking (15.3%). These groups were combined with baseline lifetime smoking status. Upward mobility was associated with decreased odds of long-term smoking compared to non-smoking, in comparison to those with persistent high/intermediate mobility, while downward mobility or persistent low mobility was associated with increased odds of long-term smoking. Furthermore, both upward mobility and persistent low socio-economic status were associated with lower odds of quitting smoking than non-smoking during the study period.

1. Introduction

Despite the well-established fact that tobacco smoking is the leading cause of cancer and other preventable diseases, the prevalence of smoking remains alarmingly high, presenting a significant public health concern¹. Since the mid-20th century, across industrialized countries smoking rates have decreased - especially among the most educated groups of the population, leading to a significant educational gradient in tobacco consumption². Currently, in high-income countries smoking is disproportionately prevalent in low-income communities, usually due to a combination of factors including higher rates of initiation and lower rates of cessation³. Previous research has found that the mediating contribution of smoking to the socioeconomic gradient of all-cause mortality was ranging from 19% to 32%⁴, underscoring the critical role of smoking in explaining health disparities. In France, smoking rates are high compared to other OECD countries⁵ and the gap in smoking prevalence between individuals with the lowest vs. the highest education levels has increased from 1.5 percentage points (pp) to 18.5 pp between 2000 and 2020⁶.

Research shows that childhood, adolescence and young adulthood are important in terms of health inequalities^{7,8}. Harmful health behaviors are more prevalent among young adults who grow up in socially disadvantaged settings⁹, due to multiple mechanisms such as high exposure to stressful life events, parental smoking, peer smoking, and academic or school difficulties which are associated with risk-taking behaviors such as tobacco use¹⁰. Intergenerational social mobility (ISM) is a widely used measure in social epidemiology and refers to the trajectory between parental and own socio-economic position (SEP)¹¹. Past studies have found that SEP over the life course is associated with smoking status is mid-adulthood^{12,13} and family income trajectory during childhood is associated with adolescent cigarette smoking¹⁴. Furthermore, there is evidence that the low SEP of grandparents has an effect on grandchildren's smoking, which is mediated through their parents' SEP¹⁵. However, in line with this, a German study has shown that young people's risk of smoking is influenced by their own level of educational rather than that of their parents and that upward mobility may protect against smoking¹⁶.

Besides well-established evidence that social mobility has an effect on adolescents' smoking status, little is still known about the relationship between ISM and long-term smoking status trajectories among middle aged adults. Estimating smoking trajectories can give an insight into longitudinal smoking patterns, which can deepen understanding of the mechanisms contributing to the socioeconomic gradient in smoking prevalence observed in adulthood.

To address this research gap, this study aims to investigate the relationship between ISM and mid-life smoking trajectories using longitudinal data collected among participants of the French CONSTANCES cohort.

2. Methods

2.1 Study population

CONSTANCES is a large French population-based cohort study of more than 200,000 volunteers randomly recruited from 2012 to 2020. The cohort is described in detail elsewhere¹⁷, but briefly participants were aged 18 to 69 years at inclusion and were invited to complete self-administered questionnaires on health-related behaviors, occupational conditions and sociodemographic factors, as well as undergo a health examination at a Health Screening Center run by the National Health Insurance System. Participants are sent by mail or by email an annual self-administered follow-up questionnaire to complete. CONSTANCES has obtained authorization of the National Data Protection Authority and was approved by the Institutional Review Board of the National Institute for Medical Research. Informed consent was provided by all study participants.

2.2 Outcome: Smoking status trajectories

Smoking status was self-reported at study inclusion, with information collected on participants' former smoking status, current smoking status, and age at smoking initiation and cessation. Annually, participants were asked about their current smoking status (yes, once pr. day at least; no or occasionally), with an average number of data points per participant of 3.5 (standard error (SE)=2.1). For those enrolled after 2012, we used information on participants' age at smoking initiation and cessation to calculate past smoking status from 2012 onwards. This resulted in an average number of data points for smoking status per participant of 7.2 (SE=2.3). Smoking trajectories from 2012 to 2020 were assessed. The trajectory including non-smokers during the study period, was combined with baseline smoking status (never smoker, former smoker, current smoker), resulting in four outcome categories for statistical analysis: 1) Non-smokers, 2) Former smokers, 3) Quitters, and 4) Long-term smokers.

2.3 Exposure: ISM

ISM has previously been used in the CONSTANCES study to assess socio-economic position from childhood to adulthood¹⁸. ISM was determined based on 1) childhood SEP, assessed by maternal and paternal occupation in adolescence (Question asked: "What was your mother's/father's socio-professional group during your adolescence?"), and 2) adult SEP, assessed by occupational grade at the time of inclusion in the CONSTANCES cohort. Both measures were determined using the standard occupational grade classification used in France, which was studied in three occupational-grade groups: 1) high (including executive, higher intellectual profession, e.g. engineer, physician), 2) intermediate (including farmer, craftsman, shopkeeper, business owner, intermediate profession, e.g. school teacher, nurse), and 3) low (clerk or manual worker, e.g. office or commercial employee, childminder). Four ISM groups were created by combining childhood and adult SEP: 1) persistent high and intermediate SEP, 2) upward mobility (from low to intermediate or high), 3) downward mobility (from high or intermediate to low), and 4) persistent low SEP. If information on childhood or adult SEP was missing, participants were excluded from the analysis.

2.4 Covariates

To study the relationship between participants' ISM and their smoking trajectory, we controlled for several self-reported covariates collected at inclusion: sex (male vs. female); age (1) less than 30 years, 2) 30 to 44 years, 3) 45 to 59 years, 4) 60 years or more); migrant status (determined by combining their citizenship (French nationality by birth, naturalized French, or foreign nationality) and their parents' place of birth (France, Europe, North and Sub-Saharan Africa, Asia and Other), resulting in three categories: 1) Parents born in France (any nationality, and parents born in France), 2) Descendants of immigrants (French nationality by birth, and at least one parent born outside France), and 3) Immigrants (naturalized French or foreign nationality and at least one parent born outside France); marital status (1) married or in a civil partnership, 2) divorced, separated or widowed, 3) never married); employment status (1) employed, 2) unemployed (unemployed, in training, no job for health reasons, no professional activity), 3) retired); chronic health characteristics (endocrine disorders, cancer, cardiovascular disorders, respiratory diseases (yes vs. no), and parental history of psychiatric disorder or suicide (yes vs. no).

2.5 Statistical analysis

To test the association between participants' ISM and smoking trajectory we proceeded as follows. First, participants' smoking trajectories from 2012 to 2020 were determined using Group-Based Trajectory Modelling (GBTM) including all participants with at least one measurement of smoking status during data collection. GBTM is a semiparametric finite mixture model for longitudinal data¹⁹. Trajectory models were estimated using a logit link, with the Bayesian Information Criteria (BIC) and Akaike Information Criteria (AIC), entropy and average posterior probabilities (APP higher than 0.7) of trajectory membership to identify the best fitting model with the least number of trajectories²⁰. The odds of correct classification (OCC) were calculated to ensure high accuracy of attribution to the group. Second, bivariate and multivariate multinomial logistic regression models were used to estimate associations between ISM and smoking trajectories. Additionally, we tested for interactions between ISM and sex and age with regards to smoking trajectories. After exclusion of those with missing information on smoking status, childhood and adult SEP, 94.4% had no missing data on covariates. Missing data on all covariates were imputed using multiple imputations with 10 imputations per missing value with fully conditional specification²¹. All statistical analyses were performed in SAS 9.4 using proc traj, proc mi, proc logistic, and proc mianalyze²².

3. Results

Smoking trajectories

Including participants with information on smoking status (n=201,731), three smoking trajectory groups were identified (**Figure 1**): 75.4% were non-smokers during the study period, 9.3% quit smoking during the study period and 15.3% were long-term smoking.

Characteristics of the study participants

In total, 163,664 subjects were included in the study after exclusion of individuals with missing data on smoking status, occupation or childhood SEP (18.9%) (See supplementary Figure S1: STROBE diagram for exclusion details). Characteristics of study participants are shown in **Table 2**. Females accounted for 53% of the study participants, and the average age was 47 years. Almost half of study participants (47%) experienced persistent intermediate or high SEP, 17% upward mobility, 17% downward mobility, and 18% had persistent low SEP. The majority of participants were born in France with French parents (81%), 10% descendants of immigrants, and 9% were migrants. Married individuals accounted for 61% of study participants, 12% were divorced, separated or widowed, and 27% were unmarried. Most of study participants were employed (71%), 10% were unemployed and 19% were retired. 3% had parental history of psychiatric disorder, 10% had endocrine diseases, 5% cancer, 16% cardiovascular diseases, and 14% had respiratory diseases.

Associations of ISM and smoking trajectories

In bivariate multinomial logistic regression models, we found an association between ISM and being a long-time smoker and quitting smoking (**Table 3**). Individuals with upward mobility had decreased odds of having a long-term smoking pattern compared to those with persistent intermediate or high SEP (OR=0.88 [0.82;0.94]). Participants who experienced downward mobility and persistent low SEP had an elevated risk smoking long-term (OR=1.50 [1.44;1.56] and OR=1.59 [1.53;1.65], respectively) compared to those with persistent intermediate or high SEP. When adjusting for possible confounders, the association remained statistically significant, with the same trends (ORa=0.91 [0.87;0.95] for long-time smoking with upward mobility, ORa=1.43 [1.38;1.49] with downward mobility and (ORa=1.55 [1.49;1.61]) for persistent low SEP, compared to those with persistent intermediate or high SEP). Both experiencing upward mobility and persistent low SEP were associated with decreased odds of quitting smoking during the study period (ORa=0.81 [0.76;0.85] and ORa=0.89 [0.85;0.94], respectively). Upward mobility was found to be associated with lower odds of being a former smoker (ORa=0.95 [0.92;0.98]) and persistent low mobility was associated with a slightly higher risk of being former smoker (ORa=1.04 [1.00;1.07]).

Additional factors associated with participants' smoking trajectories included female sex and older age. Also, participants' migrant status was associated with smoking patterns, with descendants of immigrants having an elevated risk of long-term smoking compared to native participants, but migrants had lower odds of long-term smoking. Divorced, separated or widowed individuals had higher odds of both quitting during the study period and long-term smoking than those who were married or living in a civil partnership. Being unmarried was likewise associated with elevated odds of both quitting tobacco and long-term smoking. Participants who were unemployed had increased odds of quitting and long-term, compared to those who were employed, whereas those who were retired had lower odds of quitting and

long-term smoking. Having a parent with history of psychiatric disorder was associated with higher odds of long-term smoking. Cancer and cardiovascular disease were associated with lower odds of long-term smoking, whereas respiratory disease was associated with increased odds of long-term smoking.

Stratified analyses

In additional analyses, we found statistically significant interactions between participants' ISM and sex (Wald test p-value; <.0001) and ISM and age (Wald test p-value; <.0001). Therefore, we stratified the statistical analyses by age (results shown in **Table 4**) and sex (results shown in **Table 5**). Overall, we found the same trends as in the unstratified analysis. The association between ISM and long-term smoking appeared stronger among male (ORa ranging from 0.92 to 1.84) than in female (ORa ranging from 0.89 to 1.33), but the same trends were identified in both sexes. The association between upward mobility and long-term smoking appeared stronger among the youngest age-groups for both quitting and long-term smoking. For the oldest age group (60+ years) only downward mobility was associated with a lower risk of long-term smoking.

4. Discussion

General findings

Studying participants of a large national cohort study based in France, we found an association between ISM and smoking trajectories. Persons who experienced persistently low SEP and downward ISM were more likely to be long-time smokers than those who experienced persistent intermediate or high SEP. Being upwardly mobile was associated with lower odds of being a long-time smoker and quitter, compared to participants who experienced intermediate or high SEP. For the covariates, we found quite similar results for smoking cessation and long-term smoking, which can be explained by the fact that quitting smoking requires being a smoker at some point, and therefore to some extent the same factors are associated with both smoking cessation and long-term smoking. In stratified analyses, we identified age differences, where the association between ISM and smoking trajectory appeared stronger among younger participants, among whom experiencing a downward social mobility was associated with increased odds of quitting smoking. Our findings indicate that beyond adult SEP, long-term smoking patterns are influenced by social mobility patterns since childhood. This points to the importance of early life influences on smoking patterns, which should be taken into consideration in programs aiming to encourage smoking cessation. Besides showing the association between persistent low socio-economic status and smoking trajectories, our findings suggest that adults moving downward and upward tend to adopt the behaviours of their destination group. These results are consistent with previous studies among adolescents^{15,16,23}. As in a German study including adolescents¹⁶, we find lower odds of long-term smoking among those who are upwardly mobile compared to those with persistent intermediate or high SEP, although our study focused on adults rather than adolescents. Moreover, in our age-stratified analysis, we found that the associated effect was stronger in the younger population.

Similarly, those with lower occupational grade than their parents were more likely to smoke than those with persistent intermediate or high employment, suggesting that while smoking may be stigmatized in socially advantaged individuals, it is often the norm in disadvantaged communities^{24,25}. Low SEP as adult, regardless of childhood SEP, may continue to affect smoking cessation over time, as lower income, occupation and employment status in adulthood are found to be associated with reduced opportunities to access smoking cessation treatment and cessation counselling^{13,26}. It seems that downward mobility does not reach the level of effect of having persistent low SEP, indicating that there may be some kind of protective factor for long-term smoking in adulthood through parental occupational status.

Strength and limitations of the study

The results of this study must be interpreted in the light of several limitations. First, CONSTANCES is a longitudinal cohort study based on voluntary participation, and as in other epidemiological cohorts, participation rates are low, and participants tend to be of higher socio-economic position^{17,18}. The association between ISM and smoking in mid-life may be stronger than we report since those with lower SEP are less represented in our study. Second, we have no measurement of parental, spouse or friends' smoking. Research has previously suggested that parental smoking and intention to smoke in childhood moderately mediates the associations between childhood SEP and mid-adulthood smoking status¹². As we are analyzing the impact of mobility, adjusting for parental smoking as a potential mediator in our study may have biased our results. A German study found that differences in close friends' smoking behavior partly mediated educational differences in adolescent smoking behavior¹⁶, which might also have been the case for our adult study population. Third, ISM reflects equality of opportunities including mobility in earnings, wages and education across generations, and it is important to take into consideration that mobility is relatively low in France compared to other OECD countries¹¹. Our results may therefore to some extent reflect the effect of adult SEP. Finally, the use of GBTM does not allow us to account for people who start smoking during the study period. However, as our study population is mainly adults, this is not as critical as smoking often starts in adolescence²⁷. In sensitivity analyses, we saw that the proportion of people who start smoking during the period of follow up was 2.9% of the total population.

Our study has several strengths worth mentioning to balance some of the limitations. First, the data included in the analysis were collected in a large, community-based sample of the French population. As data were collected longitudinally, we used repeated measures of tobacco smoking, and for those who were enrolled later than 2012 in the study, we were able to calculate their smoking status retrospectively due to information on initiation and cessation age. Second, we had information on the socioeconomic position of participants both in childhood and in adulthood, which allowed us to examine

ISM and smoking patterns in a thorough way. Third, we were able to use GBTM, which enables us to analyze longitudinal trajectories of smoking patterns among adults.

Findings in light of previous research and trends in smoking behaviour among disadvantaged groups

Our results show that SEP and social mobility based on occupational status is associated with individuals' smoking trajectories, which is consistent with previous findings regarding associations between childhood social position, adult occupation and smoking status^{15,16,23,28-30}. The inclusion of information on childhood SEP in our study emphasises the importance of socioeconomic difficulties early on in life as a key determinant of later health inequalities.

We did identify statistically significant interaction between ISM and sex. It has previously been suggested, that smoking contributes slightly more to the socioeconomic gradient for all-cause mortality in male than in female (smoking estimated to account for between 12%-22% of the socioeconomic gradient for all-cause mortality in male vs. 6%-19% in female)⁴. A European cross-country study investigating the effect of intergenerational educational mobility on the likelihood of smoking did indicate that both parental education and individuals' own education are important predictors of smoking among women, while among men their own education is more crucial²⁸, indicating different effects of ISM according to sex.

Smoking typically begins in late adolescence^{27,31,32}. Youth who smoke regularly are likely to maintain their smoking habit over time, the transition between adolescence and young adulthood being a propitious period for the prevention of long-term tobacco use³³. Previous research has shown that lower SEP is associated with lower initiation age^{30,34} and that this association is largely mediated by exposure to a regular adult smoker³⁵. It is found that smoking uptake occurs earlier in poor children whose parents, family and peers smoke or who therefore may consider smoking as socially acceptable^{33,36}. Furthermore, it has been found that both earlier age of cigarette smoking initiation and shorter education are associated with higher nicotine dependence^{27,37,38}. Following from this, higher nicotine dependence is associated with lower cessation rates³⁹, and individuals with low education have lower intentions to quit smoking compared to those who have higher education³⁷. Among adults aged 65 years it has been found that those with persistent low SEP, or who experience downward or upward mobility are less likely to quit smoking than those with persistent high SEP¹³. Our findings that persistently low SEP and downward mobility have the highest odds of long-time smoking pattern are in line with these previous findings.

Interventions targeting smoking in disadvantaged populations

By better understanding the mechanisms by which SEP influences smoking behaviors, which is known to have a big influence on social inequalities in health, we can develop more effective strategies to encourage smoking cessation, promote health equity and reduce the burden of disease across populations. In a situation where persons with low SEP and with downward mobility are found to be

differently exposed to smoking, there is need to pursue research in this area. For smoking cessation treatment, it is important to consider socioeconomic differences in success and need for treatment. For example, it is suggested that users of nicotine replacement have more difficulty quitting smoking than non-users, as they are more likely to be long-term smokers, having higher nicotine dependence and more intense craving, which itself is related to greater difficulty quitting⁴⁰. Furthermore, our results suggest that SEP in adolescence has an impact on long-term smoking. It can therefore be expected that preventing young people from socially disadvantaged groups from starting smoking will have a positive long-term effect on the inequality in all-cause mortality.

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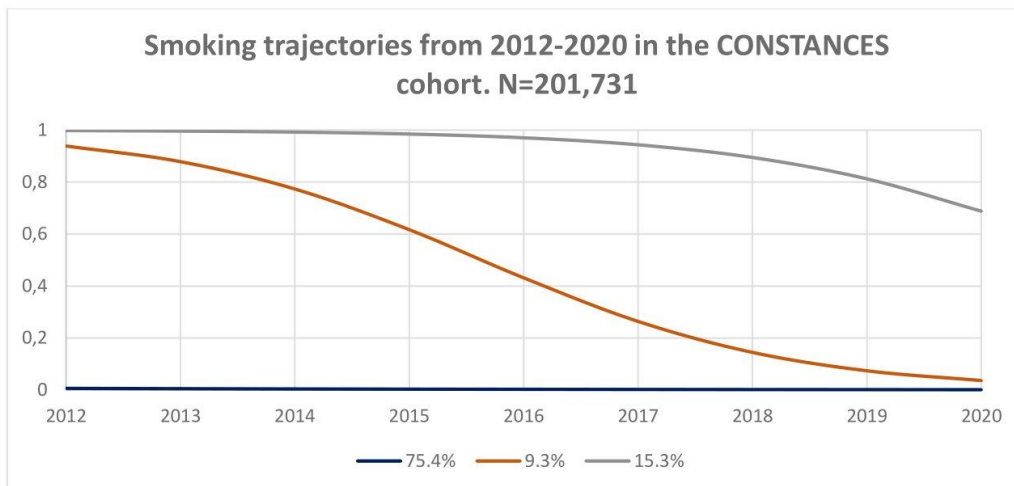
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Figure 1: Smoking trajectories among CONSTANCES cohort from 2012-2020: Group Based Trajectory Modeling. N=201,731.



Red line: Quitters, Blue line: Non or former smokers, Grey line: Long-term smokers

Table 1: Categorization of intergenerational social mobility group		
Childhood SEP	Adult SEP	Intergenerational social mobility group
High/Intermediate	High/Intermediate	Persistent high/Intermediate
	Low	Downward mobility
Low	High/Intermediate	Upward mobility
	Low	Persistent low

Table 2: Characteristics of study population collected at inclusion in the CONSTANCES cohort. Total number (%).	
	Total (n=163 664)
Smoking trajectory	
Non-smokers	78 162 (47.8%)
Former smoker	46 021 (28.1%)
Quitters	14 360 (8.8%)
Long-term smokers	25 121 (15.3%)
Social mobility	
Persistent intermediate and high	77 468 (47.3%)
Upward mobility	28 276 (17.3%)
Downward mobility	27 964 (17.1%)
Persistent low	29 956 (18.3%)
Sex	
Male	76 246 (46.6%)
Female	87 418 (53.4%)
Age	
18-29	16 976 (10.4%)
30-44	55 163 (33.7%)
45-59	53 993 (33.0%)
60+	37 532 (22.9%)
Migrant status	
French	132 527 (81.0%)
Descendants of immigrants	16 792 (10.3%)
Migrants	14 345 (8.8%)
Marital status	
Married or civil partnership	100 155 (61.2%)
Divorced, separated or widower	19 931 (12.2%)
Never married	43 578 (26.6%)
Employment status	
Employed	115 793 (70.8%)
Unemployed	17 144 (10.4%)
Retired	30 727 (18.8%)
Parental history of psychiatric disorder	
No	158 732 (97.0%)
Yes	4 932 (3.0%)
Chronic health characteristics at time of data collection	
Endocrine disease	
No	147 005 (89.8%)
Yes	16 659 (10.2%)
Cancer	
No	155 433 (95.0%)
Yes	8 231 (5.0%)
Cardiovascular disease	
No	137 495 (84.0%)
Yes	26 169 (16.0%)
Respiratory disease	
No	140 285 (85.7%)
Yes	23 379 (14.3%)
*Calculated from the declared household income divided by the square root of the size of the household, and then dichotomized around the median (Mackenbach et al. 2005)	

Table 3: Bivariate and adjusted multinomial regression; Association between intergenerational socioeconomic mobility, smoking trajectories and covariates. Odds Ratios (OR) for former smoking, quitting smoking and long-term smoking compared to never smoking. N=163,664.

	Former smokers			Quitters			Long-term smokers		
	Crude		P-value	Adjusted		P-value	Crude		P-value
	OR	OR		OR	OR		OR	OR	
Intergenerational social mobility									
Persistent high/intermediate	1.00	Ref.	Ref.	1.00	Ref.	Ref.	1.00	Ref.	Ref.
Upward mobility	1.05 [1.02;1.08]	0.0020	0.0016	0.95 [0.92;0.98]	0.0016	<0.001	0.88 [0.82;0.94]	1.00	0.91 [0.87;0.95]
Downward mobility	0.85 [0.82;0.88]	<0.001	0.9897	1.00 [0.97;1.04]	0.9897	0.7234	1.50 [1.44;1.56]	<0.001	1.43 [1.38;1.49]
Persistent low	0.99 [0.96;1.02]	0.5987	1.04 [1.00;1.07]	0.0289	0.87 [0.83;0.92]	<0.001	1.59 [1.53;1.65]	<0.001	1.55 [1.49;1.61]
Sex									
Male	1.00	Ref.	Ref.	1.00	Ref.	Ref.	1.00	Ref.	Ref.
Female	0.63 [0.61;0.64]	<0.001	0.65 [0.64;0.67]	<0.001	0.75 [0.73;0.78]	<0.001	0.72 [0.70;0.73]	<0.001	0.68 [0.66;0.70]
Age									
Less than 30	1.00	Ref.	Ref.	1.00	Ref.	Ref.	1.00	Ref.	Ref.
30 to 44	3.30 [3.13;3.48]	<0.001	3.03 [2.84;3.24]	<0.001	1.02 [0.98;1.07]	0.3125	1.21 [1.14;1.28]	0.0364	1.53 [1.45;1.60]
45 to 59	5.98 [5.67;6.30]	<0.001	5.19 [4.86;5.55]	<0.001	0.68 [0.65;0.71]	<0.001	0.81 [0.76;0.86]	<0.001	1.31 [1.24;1.38]
60 or more	7.42 [7.04;7.83]	<0.001	6.63 [6.13;7.16]	<0.001	0.38 [0.35;0.40]	<0.001	0.55 [0.49;0.61]	<0.001	0.89 [0.82;0.97]
Migrant status									
French	1.00	Ref.	Ref.	1.00	Ref.	Ref.	1.00	Ref.	Ref.
Descendants of immigrants	0.92 [0.89;0.96]	<0.001	0.99 [0.95;1.03]	0.564	1.14 [1.07;1.20]	<0.001	1.09 [1.03;1.15]	0.0045	1.21 [1.15;1.26]
Migrants	0.71 [0.68;0.74]	<0.001	0.70 [0.67;0.73]	<0.001	0.68 [0.63;0.73]	<0.001	0.65 [0.60;0.69]	<0.001	0.91 [0.87;0.96]
Marital status									
Married or civil partnership	1.00	Ref.	Ref.	1.00	Ref.	Ref.	1.00	Ref.	Ref.
Divorced, separated or widower	1.12 [1.08;1.16]	<0.001	1.00 [0.97;1.04]	0.8583	1.24 [1.17;1.31]	<0.001	1.52 [1.43;1.62]	<0.001	2.09 [1.99;2.18]
Never married	0.54 [0.52;0.55]	<0.001	0.85 [0.83;0.88]	<0.001	1.56 [1.50;1.62]	<0.001	1.32 [1.26;1.37]	<0.001	1.80 [1.74;1.86]
Employment status									
Employed	1.00	Ref.	Ref.	1.00	Ref.	Ref.	1.00	Ref.	Ref.
Unemployed	0.82 [0.78;0.85]	<0.001	1.00 [0.96;1.05]	0.9921	1.11 [1.05;1.17]	0.0003	1.13 [1.06;1.20]	<0.001	1.38 [1.32;1.45]
Retired	1.80 [1.75;1.85]	<0.001	0.96 [0.91;1.01]	0.0807	0.43 [0.41;0.46]	<0.001	0.78 [0.70;0.86]	<0.001	0.67 [0.62;0.73]
Parental psychiatric disorder									
No	1.00	Ref.	Ref.	1.00	Ref.	Ref.	1.00	Ref.	Ref.
Yes	1.21 [1.13;1.29]	<0.001	1.18 [1.10;1.26]	<0.001	1.14 [1.02;1.26]	0.0166	1.16 [1.04;1.29]	0.0057	1.18 [1.08;1.28]
Chronic health characteristics									
<i>Endocrine</i>									
No	1.00	Ref.	Ref.	1.00	Ref.	Ref.	1.00	Ref.	Ref.
Yes	1.27 [1.23;1.32]	<0.001	1.10 [1.06;1.14]	<0.001	0.81 [0.76;0.87]	<0.001	1.08 [1.01;1.16]	0.0191	1.01 [0.95;1.06]
<i>Cancer</i>									
No	1.00	Ref.	Ref.	1.00	Ref.	Ref.	1.00	Ref.	Ref.
Yes	1.47 [1.40;1.54]	<0.001	1.10 [1.05;1.16]	0.0001	0.68 [0.62;0.75]	<0.001	0.95 [0.86;1.05]	0.3474	0.94 [0.87;1.02]
<i>Cardiovascular</i>									
No	1.00	Ref.	Ref.	1.00	Ref.	Ref.	1.00	Ref.	Ref.
Yes	1.65 [1.60;1.70]	<0.001	1.14 [1.10;1.18]	<0.001	0.71 [0.67;0.76]	<0.001	0.98 [0.92;1.04]	0.5448	0.96 [0.91;1.00]
<i>Respiratory</i>									
No	1.00	Ref.	Ref.	1.00	Ref.	Ref.	1.00	Ref.	Ref.
Yes	1.06 [1.02;1.09]	<0.001	1.07 [1.03;1.11]	0.0001	1.17 [1.11;1.23]	<0.001	1.13 [1.08;1.19]	<0.001	1.10 [1.06;1.15]

Table 4: Stratified adjusted multinomial regression; Association between intergenerational socioeconomic mobility, smoking trajectories and covariates. Odds Ratios (OR) for quitting smoking and long-term smoking compared to former smoking by age group.

	Former smokers		Quitters		Long-term smokers	
	OR	95%CI	OR	95%CI	OR	95%CI
<i>Ages 29 or less years</i>	<i>N=16 976</i>					
Intergenerational social mobility						
Persistent high/intermediate	1,00	Ref.	1,00	Ref.	1,00	Ref.
Upward mobility	0.82	[0.66;1.01]	0.73	[0.61;0.87]	0.82	[0.71;0.96]
Downward mobility	1.07	[0.91;1.25]	1.26	[1.12;1.42]	1.48	[1.34;1.63]
Persistent low	1.16	[0.98;1.36]	1.01	[0.88;1.15]	1.60	[1.45;1.78]
<i>Ages 30-44 years</i>	<i>N=55 163</i>					
Intergenerational social mobility						
Persistent high/intermediate	1,00	Ref.	1,00	Ref.	1,00	Ref.
Upward mobility	0.89	[0.84;0.95]	0.77	[0.72;0.84]	0.89	[0.83;0.95]
Downward mobility	1.32	[1.23;1.41]	1.19	[1.10;1.29]	1.87	[1.75;1.99]
Persistent low	1.22	[1.15;1.30]	0.95	[0.88;1.03]	1.76	[1.65;1.87]
<i>Ages 45-59 years</i>	<i>N=53 993</i>					
Intergenerational social mobility						
Persistent high/intermediate	1,00	Ref.	1,00	Ref.	1,00	Ref.
Upward mobility	0.94	[0.89;0.99]	0.81	[0.73;0.89]	0.90	[0.84;0.97]
Downward mobility	1.11	[1.04;1.17]	0.94	[0.85;1.04]	1.45	[1.35;1.56]
Persistent low	1.15	[1.09;1.22]	0.92	[0.84;1.01]	1.63	[1.53;1.74]
<i>Ages 60+ years</i>	<i>N=37 532</i>					
Intergenerational social mobility						
Persistent high/intermediate	1,00	Ref.	1,00	Ref.	1,00	Ref.
Upward mobility	0.96	[0.91;1.02]	0.85	[0.74;0.97]	0.97	[0.87;1.08]
Downward mobility	0.68	[0.64;0.73]	0.58	[0.49;0.69]	0.84	[0.74;0.95]
Persistent low	0.76	[0.72;0.81]	0.70	[0.60;0.81]	1.00	[0.89;1.11]

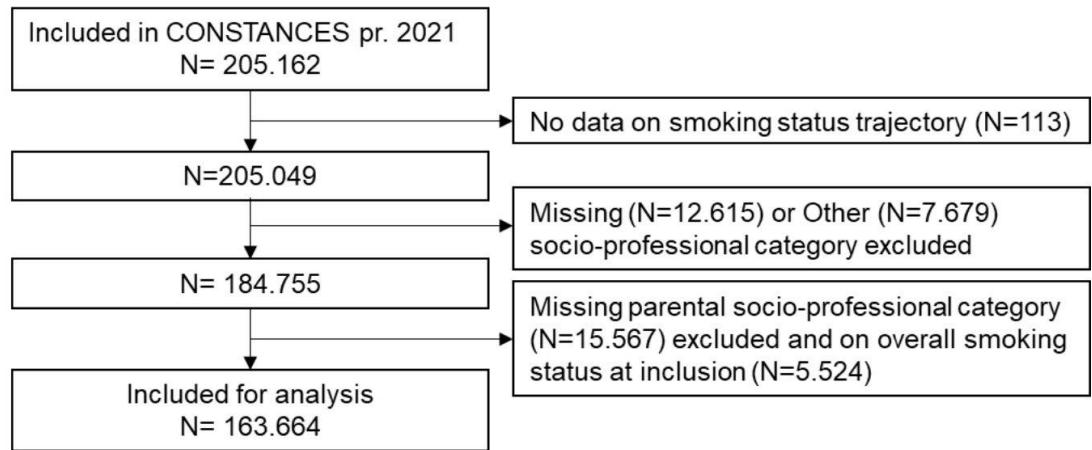
Adjusted for sex, geographical origin, marital status, employment status, parental psychiatric disorder and health characteristics, including endocrine, cancer, cardiovascular and respiratory disease.

Table 5: Stratified adjusted multinomial regression; Association between intergenerational socioeconomic mobility, smoking trajectories and covariates. Odds Ratios (OR) for quitting smoking and long-term smoking compared to former smoking by age sex.

	Former smokers		Quitters		Long-term smokers	
	OR	95%CI	OR	95%CI	OR	95%CI
<i>Male</i>	<i>N=76 246</i>					
Intergenerational social mobility						
Persistent high/intermediate	1,00	Ref.	1,00	Ref.	1,00	Ref.
Upward mobility	0.97	[0.93;1.02]	0.79	[0.74;0.85]	0.92	[0.87;0.98]
Downward mobility	1.16	[1.09;1.22]	1.04	[0.96;1.13]	1.60	[1.51;1.70]
Persistent low	1.30	[1.24;1.37]	0.94	[0.87;1.02]	1.84	[1.74;1.95]
<i>Female</i>	<i>N=87 418</i>					
Intergenerational social mobility						
Persistent high/intermediate	1,00	Ref.	1,00	Ref.	1,00	Ref.
Upward mobility	0.91	[0.86;0.95]	0.80	[0.74;0.86]	0.89	[0.84;0.95]
Downward mobility	0.89	[0.85;0.93]	0.94	[0.88;1.00]	1.25	[1.19;1.32]
Persistent low	0.87	[0.84;0.91]	0.84	[0.79;0.90]	1.33	[1.26;1.40]

Adjusted for age, geographical origin, marital status, employment status, parental psychiatric disorder and health characteristics, including endocrine, cancer, cardiovascular and respiratory disease.

Figure S1: STROBE diagram



Total n with imputation of covariates: 163 664

6. General discussion

This chapter presents a general discussion of the findings by first summarizing the thesis's contribution to international research, followed by a discussion of the methodological limitations of the thesis, and concludes with a discussion of the implications of findings and perspectives for future research.

6.1 Discussion of main results and their contribution

This section is divided into three subsections, in which each research aim is discussed in relation to other literature in the field.

6.1.1 Mental health and the first period of the COVID-19 pandemic

The first objective of the thesis was to examine the association between pre-existing symptoms of anxiety/depression and such symptoms during the initial period of the COVID-19 pandemic. By including up to seven measurements of anxiety/depression symptoms from March to May 2020 among the same individuals, we did find an elevated risk of experiencing symptoms of anxiety/depression during the pandemic among those with pre-existing symptoms. Furthermore, we found that female and individuals who felt lonely had an elevated risk of experiencing symptoms of anxiety/depression during the first phase of the pandemic.

Previous scientific literature that investigated changes in mental health disorders before and after the pandemic did not show a deterioration (Witteveen et al., 2023). Witteveen et al. highlighted, among other things, in their meta-analysis of mental health and COVID-19, that this inconsistency seems to be contrary to previous findings that indicated greater vulnerability in people with a history of mental disorders, which we also observed in our study. The inconsistency in the literature can be explained by several factors. One factor is the large individual variation among people with mental disorders, where the pandemic and the implementation of public health measures led to increase anxiety and depression symptoms for some individuals, while proving beneficial for others, such as by reducing social pressure (Witteveen et al., 2023). Our study included a majority of people with high SEP (Mary-Krause et al., 2021), and people with more serious psychiatric disorders might not have been included in the TEMPO cohort. Consequently, our findings are applicable to a very specific group of people where we are investigating symptoms of anxiety/depression.

This thesis contributes new evidence at a times where knowledge about vulnerable groups during the pandemic was limited. It demonstrates that individuals with pre-existing

anxiety/depression symptoms were more vulnerable to experiencing such symptoms at the onset of the pandemic. This finding aligns with those published by Santé Publique France, which depicts the highest prevalence of anxiety and depression at the beginning of the pandemic. The timing of data collection can have a great impact on the generated results, a topic that will be further discussed in section 6.2.3 Generalization of results on page 97.

Sun and colleagues also presented minimal changes in mental health before and after the pandemic, suggesting that this finding could reflect the efforts governments have taken to support mental health during this period (Sun et al., 2023). The World Health Organization and governments worldwide have developed strategies to address mental health and have allocated resources to support mental well-being within society. However, the extent of the effectiveness of these initiatives remains unknown, but it is possible that government actions have played an important role (*ibid.*). A mixed method study conducted in Denmark concluded that individuals in the country appeared to have managed the lockdown without alarming changes in their mental health (Clotworthy et al., 2021). The study found no substantial changes in levels of worry, quality of life, or social isolation. Conversely, another Danish study did observe poorer mental health during the strictest phases of the lockdowns, with improved outcomes noted during the reopening phase (Pedersen et al., 2022). Our data collection took place during the most severe phases of the pandemic, during which we found that individuals with pre-existing symptoms of anxiety/depression, female, and those experiencing loneliness were more likely to experience such symptoms in the initial period of the pandemic in France. Previous literature did identify negative changes in mental health among specific groups, particularly female (Sun et al., 2023), which is in line with our findings. These early pandemic findings underscore the necessity for ongoing monitoring to gauge the persistence of negative mental health changes and determine whether they require additional resources. Furthermore, women, people under the age of 34, and those with mental and/or chronic illnesses had poorer mental health during the pandemic (Pedersen et al., 2022). This observation is consistent with our results, as we found elevated odds of anxiety/depression symptoms among individuals with heightened symptoms before the pandemic. Our findings could also be a result of the long-term aspect and persistence of mental health problems, as affective symptoms like anxiety and depression tend to be relatively stable over time (Merikangas et al., 2003; Nes et al., 2007; Penninx et al., 2011; Pine et al., 1998; Prenoveau et al., 2011). The measurements used in the analysis were conducted in the early stages of the pandemic, and may therefore reflect an increased

vulnerability. It is challenging to ascertain whether this association remained stable in the long-term after the pandemic's onset.

6.1.2 Smoking status in times of a public health crisis

The second objective of the thesis was to investigate smoking prevalence in a French cohort study, with a focus on differences between education levels. First, we estimated smoking prevalence in the TEMPO cohort from 2009 to 2020, revealing higher smoking prevalence among individuals with lower education compared to those with higher education. To assess the impact of COVID-19, we looked at the interpersonal changes in tobacco consumption among smokers from 2018 to 2020, using information on smoking status and number of cigarettes smoked. Before adjustment, we found that individuals with higher education were more likely to both increase and decrease their cigarette consumption. However, after adjusting for potential confounding factors, the association remained stable for decreases, suggesting that those with higher education were more inclined to reduce their tobacco consumption between 2018 and 2020 in contrast to their counterparts with lower education. Our results fulfilled our hypothesis that the discrepancy in smoking prevalence between individuals with lower and higher education increased during the COVID-19 period. Furthermore, we found that this increase may be because of individuals with higher education being more likely to reducing their cigarette consumption than those with lower education, which is also in line with our hypothesis and with other research in the field.

Our findings must be considered within the context of existing studies on smoking during the COVID-19 pandemic, where mixed results have been reported. As highlighted by Sarich et al. (2022), divergent results have been reported concerning changes in tobacco smoking patterns before and during the pandemic. Examining how educational attainment influences tobacco smoking behaviours during the COVID-19 pandemic is crucial, and understanding which demographic groups are more likely to altering their smoking habits can provide valuable insights for shaping effective public health policies. It is essential to identify both vulnerable populations and the factors associated with smoking prevalence, as the adverse effects of tobacco usage vary based on SEP.

While working on the thesis, it became increasingly evident that the emerging literature has one major limitation. The way in which changes in smoking during the pandemic are measured in epidemiological studies varies and could contribute to the different conclusions drawn from these studies. In particular, since the COVID-19 pandemic led to major disruptions to individuals' regular routines, it may have been particularly difficult for individuals to

retrospectively keep track of their smoking levels. Most studies investigating changes in tobacco smoking are mainly based on self-reported survey questions about perceived changes in smoking habits (Bast et al., 2023; Nagawa et al., 2023; Wiley et al., 2023) (Bar-Zeev et al., 2021; Carreras et al., 2022; Constant et al., 2020; Đogaš et al., 2020; Ferrante et al., 2020; Gendall et al., 2021; Glenister et al., 2021; Gravely et al., 2021; Guignard et al., 2021; Kalkhoran et al., 2022; Koopmann et al., 2021; Kowitt et al., 2020; Reynolds et al., 2021; Stanton et al., 2020; Vanderbruggen, Matthys, Laere, et al., 2020; Vogel et al., 2021; Yingst et al., 2021; Zhang et al., 2021), which was not a predominant measurement employed before the pandemic and could be subject to imprecision (Hipp et al., 2020). As previously mentioned, there was an increased emphasis on studying changes in tobacco consumption during the COVID-19 pandemic. In these studies, a common approach was to assess perceived changes through questions such as ‘Compared to pre-lockdown, has your smoking consumption changed?’ with response options like ‘It has increased/it has remained the same/it has decreased’ (Bar-Zeev et al., 2021; Cordon et al., 2021; Guignard et al., 2021; Kowitt et al., 2020; Vanderbruggen, Matthys, Laere, et al., 2020; Zhang et al., 2021), which is not a measurement approach commonly used prior the pandemic.

In our analysis, we did not account for what smoking prevalence and smoking habits might have been in the absence of the pandemic. Previous research has demonstrated that individuals with higher education are more likely to quit smoking than those with lower education during non-crisis periods (Hiscock et al., 2012). Therefore, our results could partially reflect this expected pattern. Future research should thus consider a more long-term perspective on the impact of the COVID-19 pandemic – both on mental health and tobacco smoking, as these two factors are intricately connected, especially within more disadvantaged groups.

6.1.3 Smoking status trajectories, intergenerational socioeconomic mobility and depression

The third part of the thesis contributes to knowledge on intergenerational social mobility as a measure of SEP in two life stages and mid-life smoking trajectories. Our results highlight the existing social gradient in smoking behaviour, and furthermore, we found that upward mobility has a protective effect in terms of long-term smoking. These findings were in line with our hypothesis and provide new insights into social mobility and smoking behaviour trajectories among mid-life adults in France. Previous research on social mobility and smoking status has primarily focused on smoking in adolescence, but having knowledge about smoking patterns among adults is crucial to address.

We found that individuals who experienced low SEP both in childhood and as adults had the highest likelihood of having a long-term smoking pattern, compared to those who had a high SEP both in childhood and as adults. For those who experienced downward mobility, moving from a high SEP as a child to a low SEP as an adult, we also identified an increased likelihood of long-term smoking, albeit with a smaller effect size than for those with persistent low SEP. This result suggests that growing up in a more advantaged household reduces the chance of long-term smoking compared to growing up in a low SEP household. Experiencing upward mobility, moving from a low SEP to a high SEP, was associated with a lower odd of long-term smoking compared to a consistently high SEP, suggesting a protective effect of upward mobility in relation to cigarette smoking. The effects of both downward and upward mobility suggest that adults are likely to adopt the behaviour of their destination group, which is consistent with previous studies (Bowes et al., 2013; Doku et al., 2020; Kuntz and Lampert, 2013). These results also indicate the importance of the social environment in relation to smoking behaviour.

We included a post-COVID-19 measurement into our trajectory model, but we did not identify any trajectory showing changes in smoking prevalence during the COVID-19 period. It is important to keep in mind that trajectory modelling might not be the most obvious method for identifying changes in specific time spans. However, considering the available data, we deemed this approach to be the most compelling for our analysis. Other statistical methods that could be interesting to use to look at the impact of COVID-19 would be time series analysis or a difference-in-differences analysis. Regrettably, these methods would require a greater number of data points after the pandemic, which were not at our disposal. For long-term research, this would be an interesting aspect to contribute with.

6.2 Methodological limitations

Despite its strengths, this thesis has some limitations that I want to highlight in this section. Firstly, I will address the validity of our results owing to the use of the available measures for evaluating mental health problems, smoking status, and SEP. Secondly, I will discuss the presence of missing data. Lastly, this section addresses the generalizability of our findings.

6.2.1 Measurements

This section presents the measurements and their limitations regarding the outcomes or exposure measures used in the studies, which require a more extensive discussion than what is presented in the sections of the published articles.

6.2.1.1 Mental health in TEMPO

In the first study, symptoms of anxiety/depression were assessed using 8 to 13 items from the *Anxious/Depressed* syndrome scale, based on the Adult Self Report (ASR)-Achenbach System, which is part of the broadband scale Internalizing problems (“ASEBA - The Achenbach System of Empirically Based Assessment,” 2021). The ASR-Achenbach System is a validated tool for assessing mental health among adults and is used for both clinical and research purposes (“ASEBA - The Achenbach System of Empirically Based Assessment,” 2021; de Vries et al., 2020). Originally, the *Anxious/Depressed* scale contains 18 items, each rated on a three-point scale from 0 (not true) to 2 (very often or often true) (Ivanova et al., 2015). The TEMPO-COVID-19 study includes 8 items from the *Anxious/Depressed* scale in wave 1, and 13 items in waves 2 to 7 to calculate an anxiety/depression score during lockdown. The ASR scale has changed over time with the number of items being updated by the authors. In 2020, starting at wave 2, we decided to update the scale with the new items preconized by the authors to have the most recent version. As indicated by the authors of the ASR scale, “The Adult Self-Report (ASR) incorporate many items of the previous editions, plus items and national norms that span ages 18-59” (<https://aseba.org/adults>). The inclusion of a shortened version of the ASR scale for anxiety/depression scale may have challenged the validity and reduced the reliability of the scale with the risk of increased measurement error. Nevertheless, we consider that data of wave 1 are valid because among 13 items of the latest version, 8 items are similar, those of the oldest version, as described below:

Wave 1 (8 items)	Wave 2-9 (13 items)
I cry a lot	I cry a lot
I worry about my future	I worry about my future
I feel worthless or inferior	I feel worthless or inferior
I am nervous or tense	I am nervous or tense
I feel too guilty	I feel too guilty
I think about killing myself	I think about killing myself
I am unhappy, sad, or depressed	I am unhappy, sad, or depressed
I feel that I can't succeed	I feel that I can't succeed
	I am afraid I might think or do something bad
	I feel that no one loves me
	I feel that others are out to get me
	I am self-conscious or easily embarrassed
	I worry about my social relations with the opposite sex

We chose to include wave 1 data because the data collection occurred during the first week of the national lockdown in France, reflecting participants’ immediate and actual mental health

measured by the well-validated ASR. Moreover, a crude score was first obtained by summing all items, and then transformed to a 0-100 scale in order to create a comparable measure between different waves of follow-up.

The standard 85th percentile cut-off was used to identify individuals with elevated symptoms of anxiety/depression. After standardization of the ASR scores from 0 to 100, we calculated the 85th percentile values for each data collection to identify the average cut-off score, corresponding to a score of 34 on the *Anxious/Depressed* scale. We used this to create a comparable dichotomous measure across study waves. With this approach, changes in levels of anxiety/depression from March to May 2020 are undetectable, but in a sensitivity analysis, we did not find that levels of anxiety/depression changed over this time period.

6.2.1.2 *Smoking status and interpersonal change in smoking behaviour*

In both the second and third studies, we used smoking status as an outcome. In the TEMPO study, participants were asked about their current smoking status, as well as the average number of cigarettes smoked per day. In addition to smoking status, we also included a measure of interpersonal changes in cigarette smoking between 2018 and 2020 among smokers, which allows us to examine changes in smoking patterns with pre- and post-COVID-19 measurements by combining information on the average number of cigarettes smoked daily.

In the CONSTANCES study, participants were also queried about their current smoking status at both the time of enrolment and during follow-up. Furthermore, they also provided information concerning the age at which they initiated smoking and the age at which they ceased smoking, which allowed us to retroactively determine the smoking status of participants who joined the study at a later stage, thereby supplying us with additional data points to include into the trajectory model.

Alternative methods for evaluating tobacco smoking could involve the measurement of cotinine in blood, saliva, or urine as an indicator of nicotine intake (Raja et al., 2016). However, this approach would be considerably more extensive and expensive, and not feasible as a self-reported measure. To understand addiction, nicotine dependence could have been assessed with the Fagerström Test for Nicotine Dependence (Heatherton et al., 1991). Alternatively, pack-years could have been calculated by multiplying the number of cigarettes packs smoked per day by the number of years smoking, which could have given us an indication of the cumulative smoking exposure (Bernaards et al., 2001).

6.2.1.3 *Measurements of SEP*

Socioeconomic position is a broad term for the social and economic factors that determine the position of individuals or groups in society (Oakes and Kaufman, 2006). Different indicators of SEP can categorize groups with different exposures and identify specific as well as general mechanisms linking SEP to health outcomes. There is no single indicator universally deemed as the optimal measure (*ibid.*).

In our second study, we used education level as an indicator of SEP. Education is often used as a metric of SEP in epidemiological studies (Oakes and Kaufman, 2006). The knowledge and skills acquired through education can influence a person's cognitive functioning, increase receptivity to health education messages, facilitate access to appropriate healthcare services, and provide cognitive resources than influence decision-making regarding risk behaviours, such as smoking based on "living in the here and now versus investing in the future" (Oakes and Kaufman, 2006). The widespread use of education as a SEP indicator is partly due to its simplicity of measurement in self-administered questionnaires, which yield high response rates compared to more complex measurements like income which can be more difficult to assess. This was also the case in our study. While using a lower threshold for educational attainment (than Bac+2 or lower vs. Bac+3 or higher) might have been relevant, our sample comprised fewer participants with low education compared to the general population, making it less suitable for our specific analysis due to the lack of participants in the lower education group.

In the third study, we used intergenerational social mobility as an indicator for SEP. To assess this, we used measures of occupational categories for participants and their parents, combining this information. Intergenerational social mobility reflects the extent to which a person moves up or down the social or economic ladder across generations, thereby providing information about the impact of family background on a person's present-day SEP, and thus providing insights into long-term trends in social and economic progress (Oakes and Kaufman, 2006). In our study, we use occupational category as a SEP indicator to calculate the mobility, a methodology previously used in the CONSTANCES cohort (Melchior et al., 2018). Occupational category has also been widely used as a tool for social stratification in epidemiological studies (Oakes and Kaufman, 2006).

Alternative SEP measures that could have been used include income, various work-related indicators, wealth, or housing characteristic and amenities (Oakes and Kaufman, 2006).

6.2.2 Missing data

Like any cohort studies, some of our data was missing. Over the study period, a total of 3401 people participated in at least one wave of the TEMPO study from 2009 to 2018 (Mary-Krause et al., 2021). A comparison between participants and non-participants in the TEMPO study showed that they did not differ on main variables, suggesting non-informative attrition (Mary-Krause et al., 2021). During the TEMPO-COVID-19 study, a total of 902 persons participated in at least one of the nine data collection waves. Apart from those lost to follow-up over time, missing data resulted from non-responses to specific questions in the questionnaires. In the first study, we did not deal with this, as the analysis was based on a complete case, excluding individuals with missing information from the analysis. This approach may have led to non-response bias. In the second study, we used Inverse Probability Weighting (IPW) to account for attrition from the initial study population that was first included in the cohort, thereby mitigating some of the bias stemming from missing data. The weights were calculated based on inclusion data collected during the TEMPO cohort enrolment, the first time a participant answered a TEMPO questionnaire. This data had to be available and already at this point of data collection, the study population was selected. The use of weights therefore does not make it possible to exclude potential bias due to non-response in the data collected before inclusion. However, IPW enables us to deal with attrition after start of data collection. In the third study, which drew on data from the CONSTANCES cohort, we managed missing information by implementing multiple imputation techniques. Multiple imputation is a robust method for handling missing data, preserving sample size and reducing bias by generating multiple datasets with imputed values, enhancing statistical validity (Bartlett et al., 2015). Its flexibility and compatibility with diverse statistical methods makes it a valuable tool for improving the validity of statistical analysis with missing data (ibid.).

6.2.3 Generalization of results

The generalization of the results to general populations requires having a representative sample of the general population. The TEMPO cohort was created in 2009 with the objective to increase understanding of health problems and needs of young adults (Mary-Krause et al., 2021). TEMPO participants had previously participated in the “Children of the GAZEL” cohort study, initiated in 1991 among offspring of the GAZEL cohort study. The GAZEL cohort was created among more than 20,000 volunteers employed by the French national utilities company (EDF and GDF), to facilitate epidemiological research on various diseases and health-related factors (Goldberg et al., 2015). Consequently, TEMPO participants constitute a specifically chosen study population from the start, and thus do not reflect the general French population. Attrition

within cohorts is inevitable and not non-random, with the most disadvantaged individuals being more likely to be lost to follow-up than their less disadvantaged counterparts (Howe et al., 2013). Due to this selective attrition, the TEMPO cohort has an overrepresentation of females, individuals with higher SEP, and those less likely to report tobacco smoking (Mary-Krause et al., 2021). In the first study, since it was based on complete cases and excluded those with missing data, the results might be biased, thereby limiting the generalizability of the findings. With the use of IPW in the second study, we were able to account for attrition from the original study participants, limiting non-response bias in our analyses. The generalizability of findings from the TEMPO studies is constrained by the study's composition and size.

The CONSTANCES cohort is a general-purpose cohort intended to serve as an epidemiological research infrastructure with a focus on occupational and social factors, and on chronic diseases and aging with recruitment starting in late 2012 (Zins and Goldberg, 2015). CONSTANCES was designed as a sample representative for age, gender and socioeconomic status of the French adult population aged 18 to 69 years at enrolment. However, due to study design and partnership with the National Health Insurance Fund, the study population had to be restricted to salaried workers, professionally active or retired and their family, which is one of the limitations of the CONSTANCES cohort in terms of generalization of our results. By September 2016, more than 112,000 participants were enrolled in the cohort corresponding to a participation rate of 7.3%, which corresponds to other cohorts with voluntary participation (Goldberg et al., 2017). To control for the selection effects, a 'control cohort' was drawn from a random sample of 400,000 non-participants, who are individuals who were invited but did not participate, and from whom data on social and occupational, health and use of healthcare services were collected from the administrative databases. This data has been used to calculate sampling weights, correcting for non-participation in the study. However, these weights were not used in our analysis, as they primarily serve to calculate prevalence, which enables estimating true prevalence in the general French population. Thus, they are not relevant for our analysis.

Furthermore, the timing of data collection might have played a role for our results. There is a possibility that changes in mental health and smoking behaviour were more prevalent at specific time points during the pandemic, as it was observed in Figure 2, which shows that symptoms of anxiety and depression reach their peak at the outset of the pandemic. It can therefore be hypothesised that changes in mental health and smoking behaviour could be influenced to varying extent at distinct periods, thereby limiting the generalization of our results to a specific time period.

Despite the limitation related to the cohorts' study composition and size, both the TEMPO and CONSTANCES sample were sufficiently diverse to compare different groups. Nevertheless, the impact of pre-existing mental health difficulties on well-being during the COVID-19 pandemic, alongside changes in smoking behaviour, may be stronger in the general population.

6.3 Implications and perspectives

In this section, the implications of the findings and perspectives for future research will be presented. First, implications of the findings regarding mental health and smoking behaviour with respect to the COVID-19 research will be discussed, followed by a discussion of implications for social patterns of cigarette smoking. Finally, this section will focus on preventive interventions in light of the findings presented in this thesis.

6.3.1 Mental health, smoking behaviour and COVID-19 research

This thesis contributes to the knowledge about vulnerable groups during the pandemic. Our findings indicate that people with pre-existing symptoms of anxiety/depression are more susceptible to experiencing such symptoms during the pandemic. Within the same cohort, we also investigated smoking prevalence and found that from 2018 to 2020, individuals with higher educational attainment were more likely to reduce their smoking behaviour compared to those with lower education. Moreover, the disparities in smoking prevalence between individuals with low and high education increased during the pandemic.

Research concerning mental health and health behaviour during the pandemic has revealed more nuances than what has been presented by media articles (Bentall, 2021). As pointed out by Sun et al. (2023), short news cycles that emphasise bad news, anecdotes, and an uncritical reliance on cross-sectional studies and unvalidated survey tools inquiring about mental health and well-being during the pandemic among convenience samples might partially explain some of this observed discrepancy according to the understanding of COVID-19's impact on mental health (Sun et al., 2023). The same may be the case for cigarette smoking, where the influence of COVID-19 on smoking behaviour exhibits inconsistency. Early in the pandemic, it emerged, for example, that smoking tobacco status might be associated with a lower risk of developing COVID-19 (Paleiron et al., 2021), which was also confirmed by a French study (Miyara et al., 2022). Despite the limitations in the studies' methodology, these findings spread rapidly worldwide, suggesting a protective factor of smoking against COVID-19 (van Westen-Lagerweij et al., 2021). Researchers were quick to express their concerns about these studies and, more importantly, their conclusions (Berlin and Thomas, 2020).

What the research conducted during the pandemic has shown is that focusing on who the vulnerable are is essential when dealing with future crises. We identified two vulnerable groups during the pandemic: those with pre-existing mental health conditions and those with lower education levels, with regards to their mental health and smoking behaviour during this period. This is important due to inequalities in the pandemic's consequences and the potential long-term negative health consequences. Studies have revealed that the economic and financial impact of the pandemic has been greatest among persons with low SEP (Firlej and Pawlowski, 2021). Moreover, those with lower income are more negatively affected by the consequences of the crisis, as levels of anxiety and depression have been found highest among individuals with lower household income (Andersen et al., 2021; Fancourt et al., 2021; Pieh et al., 2020), which are both associated with elevated smoking rates. Furthermore, job losses surged during the pandemic, disproportionately affecting individuals who were already economically vulnerable before the onset of the COVID-19 pandemic (Ksinan Jiskrova et al., 2021). This knowledge is important to keep in mind when dealing with future health, climate and economic crises.

6.3.2 Social patterning of cigarette smoking

The social patterning of health behaviours, such as smoking and diet, can be understood in the context of the epidemiological transition from “diseases of affluence” to “diseases of the poor” (Mackenbach, 1994). The epidemic transition was initially described by the shift in coronary heart disease and related behaviours, which were more prevalent among higher SEP groups. However, as the epidemiological transition progressed, the burden shifted toward lower SEP groups (Marmot et al., 1978), a trend also observed in cigarette smoking. The smoking epidemic model further supports the understanding of how smoking prevalence rates differ across socioeconomic groups at various stages of the smoking epidemic. Socio-cultural factors, such as gender equality and the perception of smoking as a symbol of emancipation, particularly in higher SEP groups during the early stages of the epidemic, contribute to these disparities (Huisman et al., 2005). Regarding social mobility, observational studies consistently provide evidence of the subjective SEP impact on health outcomes. Theories like social identity theory and categorization theory suggest that individuals who perceive themselves as part of a specific SEP group are likely to share similar environments, engage in comparable activities, and mimic behaviour, leading to akin health outcomes (Gugushvili et al., 2022). Education plays a crucial role by shaping individuals' knowledge, attitudes, and behaviours, thereby ultimately

influencing their occupational class, economic resources, and exposure to hazards (Herr et al., 2015).

The discussion surrounding health behaviours, like smoking, often tends to be framed within the context of individual responsibility, disregarding the broader societal factors at play (Marmot et al., 2005). This victim-blaming approach fails to address why disadvantaged individuals are more likely to engaging in unhealthy behaviour like cigarette smoking. It also neglects the complex interplay of social and individual influences that perpetuate such behaviours, as elucidated in section 2.4.1 Interplay of factors contributing to the association between SEP and smoking status in the State of Art. Simply encouraging individuals to change their behaviour, without addressing the underlying social circumstances, is unhelpful and ineffective in promoting behaviour change within disadvantaged groups (Marmot et al., 2005). The next section discusses interventions aimed at preventing smoking among disadvantaged groups.

6.3.3 Preventive interventions

Health promotion and preventive interventions are essential in public health. However, over time, a number of researchers have emphasized the risk that public health interventions may exacerbate health inequalities by being of greater benefit to advantaged groups than to others (Nickel and von dem Knesebeck, 2020). Therefore, a “one-size-fits-all” approach to intervention may not be enough, and tailoring interventions to suit the needs of individuals or sub-groups with specific characteristics may results in better and equitable outcomes.

Several interventions to prevent a deterioration of mental health during the COVID-19 pandemic were implemented by governments worldwide. Throughout the pandemic, increased access to mental health services was facilitated through telemedicine, online counselling, and crisis hotlines to provide support (Witteveen et al., 2022). However, several barriers, such as limited technological literacy, hindering to these tools were identified, warranting further enhancement to better prepare for future crises. Additional strategies included disseminating public health messages on stress and anxiety management guidelines during the pandemic. For example, in Canada, a free mental health text-message service was launched at the pandemic’s onset, providing effective as a population-level intervention in reducing stress, anxiety, depression, and suicidal thoughts during the crisis (Agyapong et al., 2021).

Regarding preventive interventions for tobacco smoking, numerous measures have been implemented over the past decades to encourage smoking cessation and thereby curtail the

single largest preventable cause of premature death. Nicotine dependence assumes a pivotal role concerning smoking cessation, and comprehending why smoking tends to appeal predominantly to economically disadvantaged individuals, even in the face of prevention efforts, is crucial (Marmot et al., 2005). Factors such as higher initiation rates, more pronounced rewarding effects that contribute to heightened tobacco dependence, or increased difficulty in quitting due to lower motivation and limited coping resources are all elements that may mediate this association. When undertaking interventions, it is imperative to keep in mind this complex interplay of these factors, which collectively contribute to disparities in smoking prevalence.

Previous research has shown that adolescents with the lowest perceptions of long-term smoking-related risk are over three times more likely to initiate smoking compared to those with the highest risk perceptions (Song et al., 2009). Furthermore, individuals with the lowest perception of long-term risks have a more than twofold likelihood of initiating smoking (ibid.). Adolescents' decisions regarding smoking hinged on a balance of both perceived risks and perceived benefits. Consequently, when intervening to discourage smoking, efforts should not only focus on altering perceptions of long-term consequences, but should also focus on the social risks, such as having bad breath (Song et al., 2009).

Interventions put in place include on a governmental level tobacco taxation and pricing. To facilitate smoking cessation, a French study (Aubin et al., 2010), highlighted that among French adults, the two main reasons for quitting smoking are financial and social. This study was conducted just after the first dramatic tax increases on cigarettes in 2003 and 2004, after which cigarette prices have continued to rise. In both the UK and France, policies have been implemented to ban tobacco displays at point of sale, followed by the introduction of standardised packaging and price increase. Especially price-based intervention would be expected to reduce inequalities in smoking and lead to substantial reductions in smoking rates among adults and young people in lower SEP (Marteau et al., 2021). However, despite the decline in smoking prevalence over recent years, the gap in smoking rates between individuals in routine and manual occupations compared to those in other occupations has widened (ibid.), a trend similarly observed in France (Pasquereau et al., 2021).

Pricing tobacco products high appears to be the intervention with the greatest potential to reduce SES inequalities by reduce the prevalence of smoking, and to some extent decrease health risks among this group (Hill et al., 2014; Thomas et al., 2008). In terms of prices, increasing tobacco prices can have a mixed impact on social inequality in health risks associated with smoking.

On one hand, higher prices can deter some individuals, particularly those with lower incomes, from purchasing and smoking cigarettes (Hiscock et al., 2012). However, while higher prices may reduce smoking among lower-income individuals, some individuals may continue to smoke despite price increases leaving poor smokers spend a larger share of their income on tobacco consumption, potentially exacerbating existing health inequalities (Remler, 2004).

A systematic review and meta-analysis evaluated the association between population-level tobacco-control policies and different health outcomes, revealing that smoke-free legislation was associated with significant reductions in morbidity and mortality attributed to different tobacco-related diseases (including cardiovascular disease, respiratory system disease, and perinatal outcomes) (Akter et al., 2023).

Nicotine replacement therapy (NRT) is a widely used smoking cessation medication that has proven effective in achieving smoking cessation (Yilmazel Ucar et al., 2014). As described in paragraph 2.3.1 Historical smoking rates in France, NRT is 65% reimbursable in by the French National Health Insurance. A French study shows that the evolution of NRT reimbursement comes with an increase in NRT deliveries, suggesting that there is a real medical need for NRT and reimbursement acts as an important factor in access to care in France (Rochoy et al., 2022). Studies indicate that adherence to NRT is associated with successful smoking cessation (Mersha et al., 2021). Evidence also suggests that electronic cigarettes (e-cigarettes) containing nicotine increase cessation rates in comparison to NRT (Hartmann-Boyce et al., 2022). However, there is no current evidence showing whether non-combustible nicotine-containing products contribute to reducing inequalities in smoking rates (Lucherini et al., 2019).

7. Conclusion

In conclusion, this work has highlighted that individuals with pre-existing mental health problems were at greater risk to experiencing anxiety/depression symptoms during the initial phase of the COVID-19 pandemic. Furthermore, during the pandemic, persons with elevated education levels were more likely to reduce their smoking behaviour compared to those with lower education levels. Consequently, the disparity in smoking prevalence between individuals with lower and higher educational levels increased from pre-pandemic to post-pandemic periods. Given the impact of mental health problems and smoking behaviour on social inequalities in health, early prevention and health promotion are necessary from the very beginning of a crisis. Moreover, the consequences of the COVID-19 pandemic underscore the necessity for heightened vigilance to avert the exacerbation of health disparities related to SEP.

While discussing our results, we also found a large discrepancy within the literature on mental health and smoking habits during the pandemic. These contextual differences should be considered when interpreting the results of the COVID-19 segment of this thesis. The generalizability of our findings should therefore be interpreted in the context of the data collection, which refers to a very specific point in time during the pandemic within a specific population.

We were also able to show that intergenerational social mobility was associated with smoking patterns among adults. Upward mobility was associated with lower odds of long-term smoking compared to non-smoking, in comparison to those with persistent high/intermediate mobility. Conversely, downward mobility or persistent low mobility was associated with increased odds of long-term smoking. Furthermore, both upward mobility and persistently low socioeconomic status were associated with lower odds of quitting smoking compared to non-smoking over the study duration. These results indicate the importance of the social environment in relation to smoking behaviour.

Given that smoking is socially determined, it seems important to develop more personalized preventive interventions targeted toward specific SEP groups that are at higher risk of long-term smoking as well as greater risk of adverse effects of smoking.

8. References

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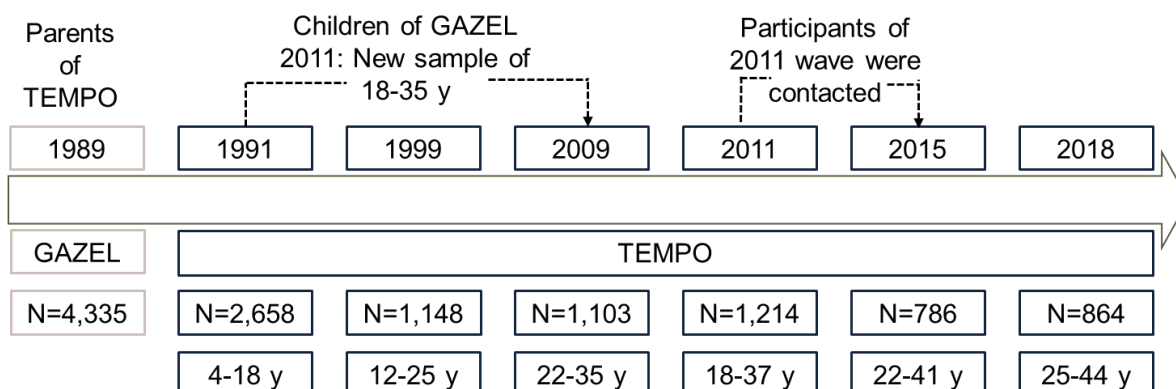
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9. Appendixes

9.1 TEMPO time line



9.2 TEMPO-COVID-19 time line

TEMPO COVID-19									
	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6	Wave 7	Wave 8	Wave 9
Period of data collection	24/03-31/03	31/03-07/04	07/04-14/04	14/04-21/04	21/04-05/05	05/05-19/05	19/05-02/06	26/06-09/07	07/12-24/04
Number of participants	424	554	493	466	428	420	386	294	654
	Lockdown							L	L