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SSTED**

ÉQUIPE de RECHERCHE IRJI François Rabelais

THÈSE présentée par : **Thomas LAURENT**

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pour obtenir le grade de : **Docteur de l'université de Tours**
Discipline/ Spécialité : Sciences Économiques

Essai sur le renoncement en économie de la santé

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List of Abbreviations

ADL	Activities of Daily Living
ATE	Average Treatment Effect
ATT	Average Treatment Effect on Treated
ATU	Average Treatment Effect on Untreated
BMI	Body Mass Index
CBT	Cognitive Behavioral Therapy
CI	Confidence Interval
CIA	Conditional Independence Assumption
CMU	Couverture Maladie Universelle
DAG	Directed Acyclic Graph
EGB	Échantillon Généraliste de Bénéficiaires
ENP	National Perinatal Surveys
EPP	Entretien Prénatal Précoce
EURO-D	European Depression scale
FIML	Full Information Maximum Likelihood
HAS	Haute Autorité de Santé
HbA1c	Hemoglobin A1c
INSERM	Institut National de la Santé et de la Recherche Médicale
IPTW	Inverse Probability of Treatment Weighting
IV	Instrumental Variable
OECD	Organization for Economic Co-operation and Development
PNP	Préparation à la Naissance et à la Parentalité
PS	Propensity Score
RMPW	Ratio-of-Mediator-Probability Weighting method
RSA	Revenu de Solidarité Active
SHARE	Survey of Health, Ageing, and Retirement in Europe
TMLE	Targeted Maximum Likelihood Estimator
UE	Union Européenne
WHO	World Health Organization

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Abstract

Cette thèse analyse l'accès aux soins de trois populations vulnérables en France : les femmes enceintes, les personnes âgées et les personnes âgées diabétiques. L'objectif est de comprendre les déterminants de cet accès et d'évaluer leur impact sur la santé et la qualité de vie.

Le premier chapitre évalue l'effet des soins prénataux sur la santé des nouveau-nés. Les résultats montrent que des soins adéquats peuvent réduire certains problèmes de santé, mais leur efficacité varie selon les comportements et perceptions des femmes. Une personnalisation des soins prénataux serait plus efficace. Le deuxième chapitre examine les besoins de santé non satisfaits chez les plus de 65 ans. L'étude révèle que les inégalités sociales et comportementales sont des facteurs déterminants. Les dépenses de santé ne diffèrent pas significativement entre ceux déclarant des besoins non satisfaits et les autres, à l'exception de la pré-fragilité et du nombre de pathologies. L'absence d'effet marginal significatif des besoins auto-déclarés sur les dépenses remet en question leur pertinence comme indicateur d'accès aux soins. Le troisième chapitre explore l'impact de la dépression sur la santé des personnes âgées diabétiques pendant la pandémie de COVID-19. La dépression a des effets indirects significatifs sur la détérioration de la santé, tandis que les effets directs du diabète ne sont pas significatifs. Cela met en avant l'importance d'une gestion intégrée de la santé mentale et physique.

En conclusion, la thèse propose des stratégies de soins personnalisées pour améliorer la santé des groupes vulnérables et orienter les politiques publiques.

Introduction

Disparités des besoins de soins entre populations

La croissance continue des coûts des soins de santé est devenue une préoccupation majeure. Au cours des trois dernières décennies, les dépenses en matière de santé ont connu une croissance beaucoup plus rapide que celle observée dans d'autres secteurs économiques. Aujourd'hui, la santé constitue l'un des segments les plus importants de l'économie dans la plupart des pays développés. Cette augmentation des coûts soulève des interrogations essentielles sur la viabilité à long terme des systèmes de santé et met en lumière la nécessité impérieuse d'optimiser l'allocation des ressources disponibles. Le concept de besoin en soins peut être compris comme l'ensemble des exigences qui bénéficieraient d'une intervention sanitaire, englobant l'éducation à la santé, la prévention des maladies, le diagnostic, le traitement, la réadaptation, et les soins palliatifs. Traditionnellement, les professionnels de santé évaluent ces besoins selon les services qu'ils peuvent offrir (Wright, 1998). Toutefois, les patients eux-mêmes peuvent avoir une conception différente de ce qui pourrait améliorer leur santé. Par exemple, ils pourraient identifier des facteurs tels que l'accès à un emploi, une ligne de bus permettant de se rendre facilement à l'hôpital ou au centre de santé, ou encore un logement de qualité comme étant cruciaux pour leur bien-être. Cette divergence de perceptions accentue la nécessité d'une approche plus globale et intégrée dans la gestion des soins de santé, considérant à la fois les

interventions médicales directes et les déterminants sociaux de la santé.

La démographie française continue d'évoluer vers une population plus âgée. On projette qu'en 2052, les personnes âgées de 75 ans et plus constitueront 16 % de la population, comparativement à 9 % actuellement. En ce qui concerne la longévité, les données de 2021 indiquent que l'espérance de vie à la naissance est de 85,4 ans pour les femmes et de 79,3 ans pour les hommes. Ces tendances démographiques soulignent l'importance croissante d'adapter les services de santé et les politiques publiques pour répondre aux besoins spécifiques d'une population vieillissante (DREES, 2007). En 2019, 24 millions de personnes ont été prises en charge pour diverses pathologies, en particulier les maladies cardio-neurovasculaires et les troubles psychiatriques (DREES, 2007). L'apparition de la pandémie de COVID-19 a déclenché une crise mondiale sans précédent, affectant les systèmes de santé, les interactions sociales et les populations vulnérables à travers le monde. En 2020, cette crise sanitaire a provoqué une augmentation significative des décès, entraînant une réduction de l'espérance de vie (Le Minez, 2021). Malgré une certaine reprise, l'espérance de vie en 2021 n'avait pas encore retrouvé son niveau d'avant la pandémie. Avec le vieillissement démographique observé depuis 2010, le nombre de décès s'accroît annuellement, mais les augmentations remarquables de 2020 et 2021 surpassent largement celles des années antérieures. Outre cette hausse globale de la mortalité, la mortalité infantile reste un indicateur particulièrement préoccupant. En 2021, la France a enregistré 2 700 décès d'enfants nés vivants avant leur premier anniversaire, alors que le nombre total de naissances s'élevait à 742 000 cette année-là. Le taux de mortalité infantile s'est ainsi établi à 3,7 décès pour 1 000 naissances. Concernant la mortalité néonatale précoce (dans les 7 premiers jours de vie), elle a évolué de 1,6 pour mille en 2005 à 2,0 pour mille en 2017, avant de légèrement diminuer à 1,9 pour mille en 2021. Par ailleurs, la mortalité post-néonatale (du 28ème jour jusqu'à moins d'un an) a continué de diminuer, passant de 1,3 pour

mille en 2005 à 1,0 pour mille en 2017 et restant stable en 2021 (INSEE, 2023).

Dès le plus jeune âge, les inégalités sociales de santé se manifestent et se développent au fil de l'enfance. Ces disparités incluent des problèmes variés comme les troubles de la vision, du langage, et de l'obésité. Les origines de ces inégalités sont complexes, impliquant l'interaction de déterminants sociaux qui s'articulent selon un mécanisme de causalité en chaîne, incluant divers facteurs psychosociaux tels que l'estime de soi, les capacités d'adaptation, ainsi que les problèmes affectifs ou les traumatismes vécus durant l'enfance. Chez les adultes, la précarité sociale, illustrée par la situation des bénéficiaires du revenu de solidarité active (RSA), est souvent liée à une détérioration de la santé, pouvant également impacter la situation professionnelle (Cambois, 2004). Le cadre de vie, les conditions de travail, et les facteurs environnementaux sont des déterminants collectifs qui engendrent des inégalités de santé et sont encore insuffisamment considérés dans les stratégies de promotion de la santé.

La France garantit une couverture santé universelle à travers l'Assurance Maladie, qui couvre une large gamme de soins médicaux, hospitaliers, et pharmaceutiques. Ceci est rendu possible par un modèle de financement solidaire où les citoyens contribuent selon leurs moyens et reçoivent des soins selon leurs besoins. L'assurance maladie obligatoire couvre actuellement 100 % de la population résidente, y compris les migrants en situation irrégulière sous certaines conditions. L'organisation institutionnelle actuelle du système de santé découle de l'intention initiale de mettre en place un système unifié, assurant des droits égaux pour tous. Les bénéficiaires de l'assurance maladie sont dispensés de payer le ticket modérateur dans plusieurs situations spécifiques, notamment : les maladies chroniques reconnues comme affections de longue durée ; les procédures liées au diagnostic et au traitement de l'infertilité ; les soins apportés aux enfants souffrant de handicaps ; ainsi que les soins nécessaires suite à des accidents de travail. Bien que la couverture soit

universelle, l'accès aux soins varie significativement entre les zones urbaines densément peuplées et les zones rurales. Les déserts médicaux, où il y a une pénurie de professionnels de santé, posent un problème majeur dans certaines régions (De-lattre, 2012). La simple proximité géographique ne suffit pas toujours à assurer un accès véritable aux soins, et il incombe également aux autorités publiques de veiller à ce que les citoyens bénéficient effectivement des services de santé nécessaires. L'adoption de technologies de santé numérique comme la télémédecine est encouragée pour améliorer l'accès aux soins, particulièrement dans les régions sous-desservies. D'autre part, le financement du système de santé repose lourdement sur les contributions des travailleurs et des employeurs, ce qui pose des défis dans un contexte de vieillissement de la population et d'augmentation des maladies chroniques. L'année 2022 marque une étape significative dans l'évolution de la Consommation de Soins et de Biens Médicaux. Elle affiche une croissance de 3,9 %, surpassant nettement la moyenne annuelle de 2,0 % enregistrée entre 2010 et 2019 (INSEE, 2022). Cette croissance est principalement due à une augmentation notable du volume des soins, qui se chiffre à 1,8 %, retrouvant ainsi les niveaux pré-pandémiques, et à une hausse des prix de 2,1 %, une augmentation sans précédent durant la décennie précédente. Cette dynamique suggère des changements significatifs dans les paramètres économiques du secteur de la santé.

Accès aux soins de santé

La notion d'accès aux soins de santé renvoie à la capacité des individus à bénéficier de soins adaptés. Parmi les obstacles qui peuvent entraver cet accès figurent divers types de barrières. Les barrières financières, par exemple, concernent l'incapacité à supporter le coût des soins. Les barrières géographiques se manifestent par une pénurie de prestataires de soins dans certaines régions ou une distance excessive à

parcourir pour atteindre ces services. Les obstacles ethniques et culturels incluent des difficultés telles que les barrières linguistiques. Enfin, les barrières temporelles se réfèrent aux attentes prolongées nécessaires pour obtenir une consultation ou un traitement. L'accès facilité à des services de santé de qualité permet une détection et un traitement précoces des maladies. Ceci est particulièrement important pour les communautés défavorisées qui sont souvent les plus touchées par des conditions de santé chroniques et qui ont traditionnellement moins accès à des soins préventifs. Malgré les différentes politiques de santé, le système de santé français reste marqué par de profondes inégalités sociales de santé. En termes d'accès aux soins primaires, les inégalités résultent principalement des différences de protection sociales. Par exemple, les individus ayant un niveau élevé de revenu consultent significativement moins les médecins généralistes, mais sont plus nombreux à consulter un gynécologue ou un autre spécialiste (Lombrail, 2005). En ce qui concerne l'accès secondaire aux soins, deux catégories d'inégalités peuvent être caractérisées : les inégalités par « omission » et les inégalités par « construction » (Lombrail, 2005). Les inégalités par « omission » proviennent du fonctionnement habituel du système de soins, marqué par une orientation principalement curative et une forte segmentation. Ces inégalités, non intentionnelles, résultent soit d'un besoin de soins non reconnu (occasion manquée d'intervention pour les professionnels ou perte de chance pour les usagers), soit d'un besoin identifié mais non satisfait. En contrepartie, les inégalités par « construction » surviennent lorsque les inégalités ne sont pas considérées dans l'élaboration de programmes ou recommandations médicales, perpétuant ainsi ces inégalités, voire les aggravant. Ces inégalités sont d'autant plus regrettables qu'une prise de conscience des facteurs sociaux permettrait de les éviter dès le départ. Par exemple, l'accès au dépistage du cancer varie selon le niveau de vie. En 2019, 24 % des femmes âgées de 50 à 74 ans parmi les plus aisées n'avaient jamais eu de mammographie ou en avaient eu une il y a plus de deux ans, contre 39

% des femmes parmi les plus modestes (DREES, 2007). Dans les départements et régions d’Outre-Mer, la prévention est moins fréquente, particulièrement à Mayotte où 85 % des hommes âgés de 50 à 74 ans n’ont jamais fait de dépistage du cancer colorectal, contre 47 % en France métropolitaine. Dans les zones rurales, on observe une pénurie de professionnels de santé, un problème auquel les pouvoirs publics tentent de remédier depuis 2004 par l’attribution d’aides financières. Ces subventions, fournies par l’État, l’Assurance maladie et les collectivités locales, visent à encourager l’installation de nouveaux médecins dans les régions les moins pourvues. Les études existantes sur les préférences de localisation des médecins en France révèlent que ces décisions sont influencées tant par des motivations personnelles que par des facteurs macroéconomiques (Delattre, 2012). L’accès aux médecins généralistes a connu une baisse significative récemment. Selon les données récentes du panel d’observation des pratiques et des conditions d’exercice en médecine générale, près de 80% des médecins généralistes libéraux estiment que l’offre de soins dans leur région est insuffisante, une augmentation de 11 points depuis 2019. De plus, une majorité de ces médecins rencontrent des difficultés pour référer leurs patients vers des spécialistes, des professionnels paramédicaux, ou des services d’aide à domicile (DRESS, 2023). Depuis 2019, l’accès aux soins de santé s’est détérioré, marqué par une augmentation du temps nécessaire pour obtenir des rendez-vous médicaux et un recours accru aux services d’urgence, faute d’alternatives appropriées. Hormis les médecins généralistes et les pharmaciens, les populations rurales continuent de subir un accès limité aux services de santé. Ces dernières doivent parcourir des distances importantes pour rejoindre différents professionnels de santé, souvent bien au-delà du temps considéré comme acceptable pour accéder à des soins (IPSOS, 2024).

Le risque moral, se manifestant à la fois ex ante et ex post, représente un défi majeur pour la durabilité des systèmes de santé. Ce concept décrit la tendance des

individus à ne pas agir dans l'intérêt de leur assureur, souvent du fait que leurs efforts ne sont pas directement observables. En amont, le risque moral ex ante incite les assurés à réduire leurs efforts de prévention, augmentant ainsi la probabilité de survenue de maladies. En aval, le risque moral ex post se traduit par une consommation accrue de soins par ceux qui bénéficient d'une assurance ou d'une couverture étendue, alimentant une surconsommation qui met à mal la viabilité financière des systèmes de soins (Bardey, 2003). D'autre part, le renoncement aux soins est un phénomène préoccupant en France, où il désigne la situation dans laquelle des individus diffèrent ou évitent de rechercher des soins nécessaires. Cette problématique concerne environ 26% des Français qui déclarent avoir renoncé à des soins à plusieurs occasions. L'impact de ces décisions est notable: plus d'un tiers des personnes concernées rapportent des conséquences graves pour leur propre santé. La situation est encore plus critique lorsque l'on considère l'impact de ce renoncement sur l'entourage familial. En outre, les barrières financières contribuent également à ce phénomène, comme le montre le fait que plus de 30% des Français ont déjà renoncé à l'achat de médicaments jugés trop onéreux (IPSOS, 2024).

Femmes enceintes et accès aux soins maternels

L'état de santé durant l'enfance et l'adolescence influence les trajectoires de vie et contribue à la construction des inégalités de santé. Les études montrent que le capital santé des descendants dépend fortement de celui de leurs ascendants, de leur environnement social, de leurs comportements en matière de santé, et de leur héritage en termes d'accès aux soins (Devaux, 2008). L'accès aux soins prénataux est essentiel pour garantir l'égalité des chances en matière de santé, car il joue un rôle fondamental dans la prise en charge des femmes enceintes, la fourniture d'informations cruciales et la promotion de modes de vie sains. Les soins prénataux permettent

de détecter et de traiter rapidement les complications potentielles, améliorant ainsi considérablement les résultats de santé pour les mères et leurs enfants (OMS, 2016). De plus, fournir des informations complètes et précises aux femmes enceintes les aide à prendre des décisions éclairées concernant leur santé et celle de leur bébé, ce qui réduit les risques de morbidité et de mortalité maternelles et néonatales (Esposito, 2015). En encourageant des modes de vie sains pendant la grossesse, comme une alimentation équilibrée, l'exercice physique modéré et l'abstinence de substances nocives, les soins prénataux contribuent à un développement fœtal optimal et à des résultats de santé à long terme plus favorables (HAS, 2005). Ainsi, des soins prénataux complets et accessibles sont essentiels pour promouvoir l'égalité des chances en matière de santé et pour rompre le cycle des inégalités intergénérationnelles. Le renoncement aux soins est influencé par plusieurs facteurs. Le premier est la situation financière, mesurée par le niveau de précarité, incluant des ressources faibles, la perception de minima sociaux, le chômage ou le temps partiel subi, le logement insalubre ou temporaire, et l'absence de couverture médicale ou complémentaire. Le deuxième ensemble de facteurs concerne les caractéristiques socio-économiques, où les femmes, les jeunes, les moins éduqués, les étrangers, les non actifs et les parents ont une probabilité plus élevée de renoncer aux soins pour des raisons financières. Le troisième ensemble de facteurs est lié aux variables psychosociales, où des expériences de vie difficiles, des perspectives d'avenir sombres, la place dans la hiérarchie sociale et l'estime de soi influencent également le renoncement aux soins. Enfin, les comportements à risque, tels que la consommation d'alcool ou de tabac et l'obésité, augmentent la propension à renoncer aux soins, notamment préventifs, pour des raisons financières (Ancelot, 2016).

De plus, les femmes de moins de 25 ans et celles issues de classes sociales défavorisées (faible niveau de scolarisation, en situation de non-emploi, sans couverture sociale complémentaire, revenu faible) ont un suivi de grossesse insuffisant. Elles

recourent moins aux examens de dépistage et se déclarent moins bien informées des recommandations sur les facteurs de risque. Le risque de suivi de grossesse insuffisant est accentué par la nationalité étrangère, le fait d'avoir plus de trois enfants, ou de vivre dans des territoires désertifiés. Certaines situations spécifiques augmentent également ce risque : avoir déjà eu un enfant ou un conjoint sans profession diminue la probabilité de réaliser les visites prénatales obligatoires, les mères isolées ont tendance à ne pas réaliser les trois échographies obligatoires, et le dépistage du virus de l'immunodéficience humaine est plus fréquent chez les femmes originaires d'Afrique subsaharienne et moins fréquent chez celles d'Afrique du Nord (Ancelot, 2016). Ces inégalités dans le suivi de grossesse se rattachent aux plus larges enjeux d'accès aux soins prénataux, qui sont essentiels pour garantir l'égalité des chances en matière de santé.

Pour pallier les disparités des soins prénataux, l'expansion significative des subventions pour les contrôles prénataux a été suggérée et mise en œuvre en 2009 au Japon, réduisant la proportion de femmes sans soins prénataux à environ 0,3 %. La majorité de ces femmes accouchent dans des hôpitaux régionaux de base (Unno, 2011). En France, la haute autorité de santé (HAS) recommande de sensibiliser les femmes enceintes aux comportements à risque pour leur santé et celle de leur enfant, et d'informer toute femme enceinte des avantages d'un suivi régulier de sa grossesse. Ce suivi est complété par une éducation prénatale lors de séances de préparation à la naissance et à la parentalité . Il est également crucial de fournir dès le premier contact des informations adaptées au mode de vie et à la situation psychosociale de la femme (HAS, 2005). L'épidémie de coronavirus, qui a entraîné un confinement de deux mois, a eu un impact significatif sur la pratique des professionnels de santé, notamment celle des sages-femmes. La téléconsultation a permis de maintenir le contact avec les femmes souhaitant obtenir une grossesse, la poursuivre ou non, et d'assurer leur surveillance et leur prise en charge malgré les distances

(Migeon, 2020). Trois actes peuvent être réalisés par télémedecine, pris en charge à 100 % : l’entretien prénatal précoce (EPP) à partir du premier trimestre, les sept séances de préparation à la naissance et à la parentalité (PNP), et le bilan de prévention. Cela présente l’avantage de limiter les déplacements pour les femmes enceintes et de réduire les inégalités territoriales.

Population âgée, maladies chroniques et accès aux soins spécialisés

L’espérance de vie a augmenté dans les pays de l’Union européenne (UE), mais ces années supplémentaires sont souvent marquées par des maladies chroniques et des incapacités. Pour faire face à ce défi, l’UE se concentre sur la prévention et le renforcement des systèmes de santé pour améliorer la gestion des maladies chroniques. Selon l’enquête SHARE, 37 % des personnes de 65 ans et plus dans l’UE souffraient d’au moins deux maladies chroniques en 2017. Les femmes sont plus touchées que les hommes (41 % contre 32 %). La fréquence des maladies chroniques augmente avec l’âge, atteignant 56 % des femmes et 47 % des hommes chez les 80 ans et plus (OCDE, 2017a). De plus, des études récentes indiquent que l’espérance de vie sans incapacité stagne depuis quelques années (Moisy, 2018) et peut même diminuer (Robine, 2017). La résistance à l’insuline, associée au diabète de type 2, favorise le développement de l’hypertension et des dyslipidémies, contribuant ainsi à l’athérosclérose et aux événements cardiovasculaires majeurs (Ginsberg, 2020). Des études montrent que les personnes présentant ces conditions combinées ont un risque cardiovasculaire beaucoup plus élevé, et une prise en charge holistique est essentielle pour réduire ce risque (Chapman, 2008). L’invalidité et la fragilité chez les personnes âgées sont fortement associées aux maladies cardiovasculaires et neurologiques. Ces maladies chroniques diminuent significativement la qualité de

vie et augmentent la dépendance fonctionnelle. En particulier, les maladies cardiovasculaires et les accidents vasculaires cérébraux constituent des causes majeures d'invalidité chez cette population, limitant leur mobilité et augmentant le risque de complications sévères (Aïdoud, 2023). Les maladies neurologiques, notamment la maladie d'Alzheimer et autres formes de démence, contribuent de manière prédominante à la fragilité, entraînant des déficits cognitifs et fonctionnels qui exacerbent la dépendance et la vulnérabilité (Spackman, 2013). Les troubles musculosquelettiques, bien qu'ils causent des douleurs et des restrictions considérées comme invalidantes, n'entraînent que rarement une dépendance complète pour les activités de la vie quotidienne (ADL) (Palazzo, 2012). En revanche, les affections neurologiques expliquent une grande part des cas de handicap sévère chez les personnes âgées, en raison du haut niveau de dépendance associé aux troubles neurodégénératifs.

Ces conditions sont souvent interconnectées, créant un cercle vicieux où les maladies cardiovasculaires augmentent le risque de troubles neurologiques et vice versa. La gestion de ces maladies chroniques est donc essentielle pour améliorer la santé et la qualité de vie des personnes âgées, nécessitant des approches intégrées et multidisciplinaires. Avec le vieillissement de la population et l'augmentation de la prévalence des maladies chroniques, la prescription de médicaments a considérablement augmenté ces dernières décennies. La gestion des personnes âgées atteintes de multimorbidité et de polymédication nécessite l'identification précoce de celles vivant avec plusieurs affections, la reconnaissance des signes de fragilité, et la prise de décisions partagées centrées sur le patient. Les cinq principes fondamentaux des soins adaptés aux personnes âgées incluent : l'importance des priorités du patient, la gestion de la complexité incluant les problèmes psychosociaux, la gestion des traitements, la prise en compte de la cognition dans les décisions partagées, et la mobilité pour gérer les problèmes de démarche et d'équilibre (Aggarwal, 2020). Pour chaque nouvelle spécialité impliquée dans le processus de soins, la probabilité qu'un patient

souffre d'un effet indésirable lié aux médicaments augmente de 12 % à 28 %, même après ajustement des facteurs de risque tels que l'âge, le sexe, la polypharmacie, la fréquence des visites chez le médecin traitant, et la morbidité (Haut Conseil de la famille, 2024). L'accès aux soins de santé est souvent entravé par plusieurs barrières, en particulier pour les populations vulnérables comme les personnes âgées. Les problèmes de mobilité sont l'une des principales barrières, limitant la capacité des individus à se rendre aux rendez-vous médicaux (Rouchaud, 2017). Les limitations physiques dues à des conditions telles que l'arthrite, les maladies cardiovasculaires ou les troubles neurologiques compliquent les déplacements, exacerbant ainsi la dépendance et réduisant l'accès aux soins. La fracture numérique représente une autre barrière significative. Avec l'augmentation des services de santé en ligne et des téléconsultations, les personnes âgées, souvent moins familiarisées avec les technologies numériques, peuvent se retrouver exclues de ces ressources (Bendekkiche, 2023). L'isolement social aggrave ces problèmes en réduisant les interactions et les réseaux de soutien. Les personnes isolées socialement sont moins susceptibles de recevoir l'aide nécessaire pour accéder aux soins de santé, que ce soit pour organiser des rendez-vous, se déplacer, ou comprendre les instructions médicales. Enfin, la désignation d'un médecin traitant peut être une barrière supplémentaire (Haut Conseil de la famille, 2024). Dans certaines régions, il peut être difficile de trouver un médecin généraliste disponible pour prendre de nouveaux patients, ce qui complique l'accès continu et coordonné aux soins. Cette situation est particulièrement problématique dans les zones rurales ou sous-desservies, où le manque de professionnels de santé est plus prononcé (DRESS, 2021; DRESS, 2023). Une étude transversale de la population montre que près d'un quart des personnes âgées en France ont des besoins de soins de santé non satisfaits. Le principal besoin identifié est le manque de soins dentaires, en raison de la prévalence élevée des problèmes de mastication par rapport aux problèmes auditifs et visuels. La situation socio-économique influence

le risque de besoins non satisfaits en matière de santé, mais les principaux facteurs de risque identifiés sont l'âge avancé et le fait d'être confiné à domicile (Herr, 2014). Pour améliorer l'accès aux soins, plusieurs stratégies et initiatives ont été mises en place. Le déploiement de communautés professionnelles territoriales de santé vise à renforcer la coordination entre les différents acteurs du système de santé. Des dispositifs d'appui à la coordination sont également instaurés pour faciliter les parcours de soins complexes, en assurant une meilleure prise en charge des patients ayant des besoins multiples. Les hôpitaux de proximité jouent un rôle clé en offrant des services de santé accessibles à tous, notamment dans les zones rurales (Haut Conseil de la famille, 2024). Ces derniers peuvent apporter des solutions pour la pratique de la téléconsultation. Par ailleurs, il est essentiel de définir des objectifs de soins en accord avec les préférences des patients, en intégrant leur voix dans le processus de décision.

Objectifs

Cette thèse se concentre sur l'analyse de l'accès aux soins dans trois populations vulnérables distinctes : les femmes enceintes, les personnes âgées, et les personnes âgées diabétiques. Dans le premier chapitre, nous explorons l'impact des soins prénataux sur la santé des nouveau-nés. En France, malgré l'importance cruciale des soins prénataux, le taux de mortalité néonatale précoce reste élevé par rapport à d'autres pays européens, et l'efficacité des programmes prénataux est encore incertaine. L'objectif est d'évaluer les effets des soins prénataux appropriés en tenant compte des caractéristiques démographiques, psychosociales et cliniques des femmes enceintes, afin de mieux comprendre les déterminants de la santé des nouveau-nés. Le deuxième chapitre se concentre sur les personnes âgées, une population dont la taille devrait augmenter considérablement d'ici 2050. Alors que la consommation de

soins est souvent utilisée comme mesure des besoins de soins, le renoncement aux soins offre une perspective subjective mais cruciale sur les obstacles rencontrés. Ce chapitre vise à caractériser les différences entre ceux qui déclarent renoncer à des soins et ne renonçant pas, en examinant les implications pour l'accès aux soins et la qualité de vie des personnes âgées. Enfin, le troisième chapitre aborde la situation des personnes âgées diabétiques, une sous-population particulièrement vulnérable en raison de la polymorbidité et de l'impact de la pandémie de COVID-19. Avec une prévalence élevée de diabète et une relation étroite entre la santé mentale et physique, ce chapitre évalue l'impact de l'isolement et du confinement sur l'état de santé général et l'état dépressif de ces individus. Cette analyse a pour objectif de fournir des données probantes afin d'améliorer les stratégies de gestion et de suivi des patients diabétiques âgés, en mettant particulièrement l'accent sur les liens entre l'isolement social et la détérioration de la santé. En combinant ces trois volets, cette thèse offre une vue d'ensemble des défis et des opportunités pour améliorer l'accès aux soins dans des populations particulièrement vulnérables.

Chapter 1

Better scan personalities than bodies? Prenatal care to enforce a pregnancy self-commitment

1.1 Abstract

The purpose of this work was to measure the effect of the proper prenatal medical care on the health of newborns. This study was based on a survey conducted in France in 2010 by the National Institute for Health and Medical Research and the Ministry of Health. Three different definitions of newborn health (mild, moderate and severe) were used, and the definition of proper prenatal care was set based on the recommendations of the Haute Autorité de Santé (HAS). The analysis was conducted based on propensity score methods to adjust for potential confounders. The results showed that if allowance is made for mothers' perceptions of their pregnancy, medical prenatal care does not always directly impact newborn health. A subpopulation of women may use prenatal care visits to enforce a self-commitment, to adhere to personal "good conducts". Better customization of prenatal care, not

exclusively medical, according to pregnant women profiles (e.g. behaviour) might be more effective and cost-saving.

1.2 Introduction

Childbirth is the most common reason for inpatient stay in numerous countries, and understanding the determinants of the care pathway leading to this situation has tangible implications including birth delivery (including resources involved), and maternal and foetal health. Genetic and social health inequalities, and inter-generational mechanisms (Jusot, 2013; Trannoy, 2010) may impact the health of both mothers and children, and potentially children development. A number of studies (Barouki, 2012; Bhalotra, 2017; Kramer, 2000; McIntire, 1999) show that nutritional and environmental factors markedly affect the development of both foetus and children: premature birth, low birth weight, malformation, childhood and adulthood morbidity-mortality. Negative attitudes during pregnancy, including poor dietary habits, exposure to sources of pollution or toxicity, adoption of risk-prone behaviour such as smoking, drinking or taking drugs, also expose the foetus to a short- and/or long-term health deterioration. Several studies (Abrevaya, 2002; Abrevaya, 2008; Almond, 2005; Cattaneo, 2010; Grossman, 1990; Reichman, 2009) report for example that, all else equal, mothers who smoke during pregnancy tend to give birth to infants with lower body weight. Abnormal birth weights can cause long-term health problems. For example, Vasylyeva (Vasylyeva, 2013) found that heavier birth weight is associated with risk of obesity in childhood or adolescence and (Morrison, 2016) found increased risk of developing dysglycemia and higher blood pressure in adults born with extremely low birth weight. Figlio (Figlio, 2014) shows that birth weight is an explanatory variable of cognitive development throughout the school career. Given the negative impact of health problems at

birth, ensuring that children are born in good health is a worthwhile social objective.

In order to reduce health inequalities and the risk of health problems at birth, the World Health Organization (WHO) recommends actions to ensure satisfactory medical monitoring of pregnancy for all women¹. While ensuring minimum compliance with these recommendations, most developed countries have introduced a number of actions to ensure satisfactory medical care during pregnancy and even social care as in Germany or the United States. France does not have any specific social program for expectant mothers. Prevention is provided by HAS², which are more stringent than World Health Organization (WHO) recommendations. France also has a very advantageous system of social protection and mechanisms for maternity coverage (DREES, 2017). In 2013, 7.3 billion euros, i.e. 4 per cent of the social security budget, were given over to maternity care, including pre- and post-delivery care. Non-hospital care during pregnancy is estimated at around 1 billion euros. Spending on maternity provision has been multiplied by 2.5 since 1990. This rise, which is higher than for other health expenditures, cannot be explained by the growth in birth rate, since this latter has been decreasing (CdC, 2014). Yet despite the health system's generosity and the observed increase in expenditures, the conditions in France in terms of peri-natality and mothers and children's health remain below that of other countries (CdC, 2012). In 2009, out of the 27 countries of the European Union, France ranked 10th for early neo-natal mortality (1.8 deaths per 1,000 births), 17th for infant mortality (3.9 deaths per 1,000), and 25th for peri-natal mortality (13.8 deaths per 1,000) and for stillbirths (12.0 deaths per 1,000)

¹Four visits to a health professional and two ultrasound scans.

²The HAS is an independent public authority that contributes to regulation of the health system through quality. Its main missions are to evaluate health products and professional practice and to oversee the organization of healthcare and public health. It makes recommendations in terms of healthcare or strategies for covering certain conditions. Lastly, it certifies health establishments and accredits practitioners. Expectant mothers are advised to see health professionals seven times and to have three ultrasound scans.

(HCSP, 2012). It can therefore be questioned whether such a system is effective and relevant, and what prenatal policy governments should introduce to ensure good health at birth. In an attempt to answer this question, we assessed the impact of prenatal care provision as recommended by the HAS on newborn health, as measured by the corpulence³. Prenatal care involves a set of clinical and biological examinations, provision of information, and preventive acts to support expectant mother in their pregnancy as best as possible. In this study, we assumed that an expectant mother engages in poor prenatal care, and therefore would implement an inadequate level of prevention, when not following the minimum care program recommended by the HAS.

Despite the widespread idea that prenatal care programs improve child health, not all studies concur on this hypothesis. Some studies have shown that a shorter prenatal care period was associated with a lower birth weight (Conway, 2005; Currie, 2002; Grossman, 1990; Warner, 1995). This insufficient duration may be offset by a greater number of visits during the prenatal care period (Warner, 1995) or by the fact that the pregnancy is “normal” (Conway, 2005). In their evaluation of the “nurse-family partnership program” (Heckman, 2017) highlighted a positive and significant effect of prenatal care on birth weight, but among boys only. Other studies reported a very slight impact of late prenatal care (Li, 2003) or of the number of visits (Rous, 2004; Sonchak, 2015) on birth weight. Lastly, a serie of studies shows no evidence of any effect. Evans (Evans, 2005) found no significant impact of the number of visits to a health professional on birth weight, and the evaluation by Sandner(Sandner, 2018) of a program of pre- and post-natal visits to disadvantaged expectant mothers have shown no effect of prenatal care on the health of either mother or child. Corman provide a detailed review of the literature(Corman, 2018). The findings of the present study on a sample of expectant mothers in France show

³Three visits and one scan more than WHO recommends.

that it is possible to reconcile the discrepancies in the effect of prenatal care in the literature by making allowance for mothers' perceptions of their pregnancy. More specifically, prenatal medical care does not seem to have a direct impact in most cases, and may possibly have an indirect "psychological" impact. We supposed that a non-negligible subpopulations of women might use such visits to adhere to personal "good conduct" commitments. Others may not adhere to the program since they may either not need or not seek healthcare services.

In light of these findings and given the cost of prenatal care system, it seems reasonable to rethink the current system. For instance, reducing the number of medical procedures (medical visits or ultrasound scans) for some groups of women would bring substantial savings. Some of those savings could be used to propose "psychological" support for women who need it to improve newborn health outcomes. Mukhopadhyay find evidence indicating inefficient resource utilization between high-risk (presence of diagnoses) and low-risk women(Mukhopadhyay, 2008).

The rest of the paper is structured as follows. First we present the source and the sample, the variables of interest and the empirical strategy. Then we provide the main descriptive statistics associated with the data and determine the effect of a poor prenatal medical care on newborn health. We conclude by presenting the implications and limitations of this study.

1.3 Materials and methods

1.3.1 Source and sample

In France, Institut National de la Santé et de la Recherche Médicale (INSERM) regularly conducts the National Perinatal Surveys (ENP) on pregnancy monitoring. The last survey was performed in 2010. These surveys are conducted at regular in-

tervals among all French maternity hospitals in both the public and private sectors⁴. The database includes all live births during one representative week in 98 per cent of French maternity wards. More than 11,000 women were interviewed during their maternity period. We consider 10,717 expectant mothers (and as many live-born infants because the database available to us did not include multiple births or infants dead at birth) for which we observe complete informations about prenatal care and newborn health. In this survey, socio-economic, demographic, psycho-social and health characteristics of each woman are collected. Moreover, this database contains information from mother and newborn's medical records completed by health professionals in charge of the ENP for each maternity ward.

1.3.2 Variables

Outcome variables

Prenatal care The information in medical records relates primarily to the nature (and number) of consultations and medical examinations of the mother during pregnancy, the medical history of the expectant mother, the birth, and newborn health (in utero, at birth, and on leaving the maternity ward). As previously mentioned, in order to reduce the risk of health problems at birth and also health inequalities, WHO recommends actions to ensure satisfactory medical monitoring of pregnancy for all women. For pregnancy healthcare, France follows the standards implemented by the HAS. This institution has drawn up a set of pregnancy preventive measures that are more stringent than those established by WHO. Within the French system, the costs of pregnancy-related healthcare are entirely covered. The perinatal

⁴The ENP (1995, 1998, 2003, and 2010) were conducted by the National Institute for Health and Medical Research (INSERM) under the aegis of the Department of Research, Surveys, Evaluation, and Statistics in conjunction with the General Department of Health and the area coordinating doctors of the Centres for Mother and Child Protection. The information concerning psycho-social variables is collected through structured interviews. Since the creation of this survey 30 years ago, the reliability/validity of this information for capturing the mother's psycho-social status has been tested and adjusted using different evaluation methods.

care variable is defined by comparing HAS official recommendations to actually performed perinatal healthcare. These healthcare procedures are identified by using the information from the mother’s medical records. According to HAS Guide, a woman has a proper prenatal care if she follows (i) at least seven prenatal visits, (ii) at least three ultrasound examinations⁵. We aimed to test the effect of the medical standard fixed by the HAS. Thus, based on HAS recommendations, we defined poor prenatal care as not following the minimum number of consultations and ultrasound examinations.

Newborn health Newborn physical characteristics (length, weight, head circumference) and certain medical characteristics (resuscitation and/or transfer of the child at birth, congenital anomaly) are observed in the survey. Using this information, newborn health was defined using three definitions, corresponding to three different degrees of severity of health problems. Here, rather than just using newborn weight as an indicator of health problems, we opted for a more encompassing definition as head circumference and length were both associated with health problems in newborns (Berngard, 2018; Sutan, 2018). The definitions for mild and moderate health problems were based on WHO Child Growth Standards and relate to newborn corpulence: birth length and weight, and head circumference. In this study, we defined newborn health problems as (i) mild if it belongs to the five most extreme percentiles and (ii) moderate if it belongs to the one most extreme percentiles, for at least one of the three index of corpulence⁶. Finally, for the definition of the highest severity degree, we included problems requiring medical intervention, i.e newborn resuscitated, diagnosis with a congenital anomaly, or transfer to an-

⁵We just consider consultations and ultrasound scans in this work. Screening practices recommended during pregnancy are omitted for two reasons: only two mandatory examinations are observed in the database: the test for Down’s syndrome and HIV testing. It appears that not carrying out these tests has no impact on newborn health, whatever definition is used.

⁶Although Apgar could be used to measure newborn health problems, Apgar score was not observed for all newborns.

other department. Unfortunately, mortality could not be considered in this study since all newborns were alive.

Explanatory variables

The survey provides several types of information relating to mothers and were used as explanatory variables of prenatal care and newborn health. First, the socio-economic variables were : age, education, nationality, occupational status, family and household income, mutual supplementary insurance (binary), and geographical location. Second, health related characteristics (binary variables) before pregnancy considered were as follows: obesity, problems during past pregnancies, and presence of the treatment for pregnancy. Variables relating to health problems during pregnancy considered in this study were weight (classified as underweight, normal and overweight), cesarean delivery (binary). Of note, the information whether cesarean was planned or not was not available. Also, two psychosocial binary variables were considered in this analysis: presence of close friends or family, and a binary variable whether the pregnancy was wanted or not. Finally, we included the following behaviour binary variables: drinking status, information about pregnancy and smoking status.

1.3.3 Empirical strategy

Main models

Firstly, we measured the effect of proper prenatal care on the probability of health problems in newborns using a probit model, assuming the exogeneity of prenatal care. Consequently, the endogeneity of this decision should be considered when conducting the econometric analysis to account for selection bias. Also, the presence of any unobserved characteristics affecting both the prenatal care and newborn health would lead to biased estimates if not properly addressed. Although bivariate probit

model could be an adequate option for accounting for a potential endogeneity bias, estimation using this method would require the identification of an instrument variable, that is a variable directly influencing prenatal care and impacting newborn health problems through prenatal care only. However, no potential candidate variable could be found in the database. For this reason, we adopted the framework of potential outcomes which is also known as Neyman-Rubin causal model (Rubin, 2005).

This framework relies on the comparison of the potential outcomes Y_1 and Y_0 , corresponding to newborn health under proper prenatal care versus newborn health under poor prenatal care, respectively.

To implement this method, we used the propensity score (PS), defined as the probability of a pregnant woman to follow proper prenatal care according to the individual characteristics. PS methods rely on the conditional independence assumption (CIA), which assumes that all variables that influenced treatment assignment and the potential outcomes are observed. PS score was estimated for all individuals using probit regression with the following variables as explanatory variables: socio-economic and woman's health problems before the pregnancy.

First, we matched pregnant women with proper prenatal care with those with poor prenatal care according to the estimated PS using nearest neighbor matching with a ratio 1:1 and a caliper of 0.1 (commonly used for propensity score matching).

ATT, defined as $P(Y_1|T = 1) - P(Y_0|T = 1)$ with T as the treatment assignment, was estimated as the difference of the mean between the outcome (newborn health) between the two groups⁷.

Secondly, we performed IPTW analysis which allows to estimate also other average marginal effects, i.e Average Treatment Effect (ATE) and ATU. ATE and ATU are defined as $P(Y_1) - P(Y_0)$ and $P(Y_1|T = 0) - P(Y_0|T = 0)$, respectively. In this study,

⁷Analysis was conducted in R using MatchIt package.

ATU was also evaluated because we aimed to characterize the potential impact of proper prenatal care among pregnant women not following the recommendations. IPTW method allows to reduce the confounding by adjusting the contribution of each observation i to the outcome model by using a weight w_i . W is defined differently for each effect, for example ATE weight was defined by Xu(Xu, 2010) as $w_i = T_i \times \frac{p}{\hat{P}(T_i=1)} + (1 - T_i) \times \frac{1-p}{(1-\hat{P}(T_i=1))}$, with $\hat{P}(T_i = 1)$ as the estimated propensity score and p the empirical proportion of women presenting proper prenatal care in the sample. Stabilisation of the weight can help to provide a more suitable estimate of the variance in presence of extremely large weights⁸. This method was reported to confer a better performance compared to the propensity score matching (Austin, 2010).

Thirdly, to assess the robustness of marginal effect estimations, Targeted Maximum Likelihood Estimator (TMLE) method was implemented. TMLE is a double-robust maximum likelihood estimator used as an alternative method to propensity score methods to estimate causal effects, and allows the implementation of machine learning methods. In brief, the TMLE algorithm uses information in the estimated treatment assignment mechanism to update the initial estimator of the conditional expectation of the outcome given the treatment and the set of covariates. This allows to reduce the bias in the initial model. The standard errors were obtained by using the efficient influence curve (Luque-Fernandez, 2018)⁹.

In this study, there are potential unobserved confounders, such as genetic characteristics relating to the newborn and pregnant women. Hence, to assess the robustness of CIA, a sensitivity analysis was performed based on the method described by Ichino(Ichino, 2008). Ichino(Ichino, 2008) proposes a method based on Rosenbaum method (Rosenbaum, 1987; Rosenbaum, 1983a; Rosenbaum, 1983b). It consists

⁸For estimating each marginal effect, the R package WeightIt was used to estimate the weights of each individual.

⁹Package TMLE in R was used to obtain the average marginal effect estimates.

in assuming that conditional independence on observable variables is not satisfied but would be if an additional binary variable was observed. This variable is supposed to have an impact on both the treatment variable and newborn health variable. Empirically, this consists in estimating ATT by setting four probabilities, $p_{jk} = P(U = 1|T = j, Y = k)$ with $j, k \in \{0, 1\}$, corresponding to the simulated variable U . These probabilities characterize the conditional distribution of U by prenatal care and newborn health status. For each assumption on the distribution of U , the effect of U on prenatal care and on newborn health are evaluated by estimating the corresponding odds ratios, Λ and Γ , respectively. Changes in ATT estimates were assessed using different calibrations of probabilities for U , based on the observed explanatory variables. Additionally, we conducted another sensitivity analysis by estimating the E-value, which is defined as the minimum strength of association, on the risk ratio scale, to nullify the observed association between the treatment and the outcome (VanderWeele, 2017).

Stratified analysis

Firstly, previous studies showed that risk-prone behaviour such as drinking or smoking adversely are pregnancy risk factors (Abrevaya, 2002; Abrevaya, 2008; Almond, 2005; Cattaneo, 2010; Grossman, 1990; Reichman, 2009). Psychosocial problems may add to these factors: women who feel that they have little support and/or who did not want the pregnancy are more likely to engage in poor prenatal care. Social support contributes to providing women with the emotional and practical resources that they need, and has a protective effect on their health. Such social support may also promote healthier behaviour and help in the smooth running of the pregnancy (Berkman, 2000).

Moreover, an extensive psychology literature (Guardino, 2014) has shown that, during pregnancy, psychosocial factors (e.g., isolation, social support, marital dissat-

isfaction, no-wish to have the baby to come) affect the pregnant women mental state. In particular, there is evidence that the aforementioned psychosocial factors are associated with stress, anxiety, fear of pregnancy and childbirth. Moreover, the mothers-to-be mental state has been found to be associated with pregnancy lifestyle (Omidvar, 2018), which in turn might affect the level of the prenatal medical care adherence.

Given the prevention campaigns concerning risks for the newborn arising from drinking and smoking, the decision to having these behaviours during pregnancy is certainly to some extent at least endogenous (Cattaneo, 2010; Conway, 2005). As taking account of double endogeneity is not a straightforward matter, we opted to work on subgroups that are more homogeneous in terms of attitude (positive and negative) and feelings. Using multiple correspondence factorial analysis, we created a score covering drinking and smoking as well as psychosocial characteristics. In total, women were classified into three groups. The first group, defined as “low risk” (37% of women), consisted of women not smoking and drinking, or who stopped these behaviours upon learning they were pregnant. In this group, pregnancy was wanted and women said they were well supported. The second group (10% of women), defined as “high risk”, consisted of 100% of women that did not want the pregnancy and said they were unsupported. They drank and smoked more than the average in the overall sample. 12 % reported smoking more than 10 cigarettes a day and drinking alcohol regularly. The third group (53% of women), defined as “Others”, was defined as women in neither of the previous two groups. For each of these subgroups, the different treatment effects, i.e ATT, ATU and ATE, were estimated.

Secondly, Ancelot reported evidence that a past experience of pregnancy tends to raise the poor prenatal care rate (Ancelot, 2020).

Poor prenatal care might, then, be synonymous with trouble-free pregnancy. In

order to test the effect of experience, a second stratified analysis was considered by comparing pregnant women with and without experience of pregnancy.

1.4 Results

1.4.1 Descriptive statistics

The main descriptive statistics in [Table 1.1](#) show that women have different characteristics depending on whether or not they engage in prenatal care¹⁰. These statistics highlight significant differences in terms of country of origin, household income, risk-prone behaviour during pregnancy, experience of pregnancy, and mother's health (before and during pregnancy).

[Table 1.2](#) shows the proportion of newborns in poor health as a function of the mother's prenatal care. Regardless of the definition considered for newborn's health problems (mild or moderate), the proportions of health problems are significantly different between prenatal care groups: more than 7 percentage points increase for mothers with poor prenatal care. These differences are such that the moderate health problems are twice as high when the expectant mothers have poor prenatal care. Proportions of severe health problems (transfer and congenital illnesses) are not significantly different (1.8 per cent deviation). Based on the stratified analysis based on risk-prone behaviours, poor prenatal care rate was 6 per cent for "low risk" group and 15.6 per cent for "high risk" group ([Table 1.2](#)), suggesting a lower rate when the degree of commitment is lower. Moreover, problems relating to corpulence presented an negative association with the degree of risk-prone behaviour, although severe problems were relatively stable.

In addition to behavioural differences, we can notice social inequalities between low-risk and high-risk women's characteristics. The latter are less educated, younger,

¹⁰For details on the database and these profiles, see (Ancelot, 2016).

Table 1.1: Descriptive statistics of pregnant women

		All	Prenatal care poor	proper
Socio-economic determinants				
Education***	No degree - High school diploma	45.0	64.2	43.3
	Post-graduate degree	55.0	35.8	56.7
Age***	Less than 25 years	16.0	24.2	15.2
	[24, 35[	65.6	55.8	66.5
	35 years and more	18.4	20.0	18.2
Nationality***	French	89.2	77.6	90.3
	European	2.5	3.7	2.4
	African	5.0	11.1	4.4
	Other	3.3	7.6	2.9
Maternal employment status***	Employed	70.1	49.3**	72.0
	Out of the work force	14.3	29.5**	12.9
	Unemployed	15.6	21.2**	15.1
Location: Paris	yes	16.3	17.6	16.2
Family status***	single	7.1	15.2**	16.2
	couple	92.9	84.7**	93.6
Household income band (€)***	less than 2000	48.2	69.1	46.3
	[2000, 4000[	36.9	22.6	38.2
	4000 and more	14.9	8.3	15.5
Mutual supplementary insurance***	yes	84.2	63.5	86.1
Psychological determinants				
Close friends or family***	low	4.9	11.2	4.4
Wanted pregnancy***	yes	87.1	76.2	88.1
Health before pregnancy determinants				
Health problem before pregnancy	yes	3.2	3.0	3.2
Obesity problem***	yes	11.3	15.5	10.9
Past pregnancy***	no	33.3	24.6	34.1
	yes, without problems	32.2	39.1	34.1
	yes, with problems	34.5	36.4	31.9
Treatment for pregnancy***	yes	18.0	9.9	18.7
Risk behaviour during pregnancy determinants				
Smokes during pregnancy***	yes	17.4	25.5	16.7
Drinks alcohol during pregnancy	yes	21.3	20.5	21.4
Information about pregnancy***	yes	59.5	54.2	60.0
Current pregnancy determinants				
Mother's weight***	underweight	20.4	30.9	19.5
	normal	48.1	42.4	48.6
	overweight	31.5	26.7	31.9
Health problems during pregnancy*	yes	9.1	7.4	9.2
Caesarean	yes	18.2	17.5	18.5
The baby is a girl	yes	47.5	46.0	47.6
Stratified analysis				
Behaviour category***	High risk	10.0	19.3	9.5
	Low risk	37.0	26.3	37.5
	Others	53.0	54.4	53.0
Health problem severity	mild***	18.5	25.7	17.8
	moderate***	9.4	15.9	8.8
	severe	9.1	10.5	9.0

Source: Present authors after ENP 2010. Notes: 55% of the women in the sample have a post-graduate degree. This percentage rises to 35.8 for women who have a poor prenatal care. *** Significant effects at 1%. ** Significant effects at 5%. * Significant effects at 10%.

single, jobless, with low incomes and less medically insured (Table 1.2).

Table 1.2: Proportion of newborns with health problems

	Newborn health problem	Subsample mean	Prenatal care: poor proper	
Entire sample (poor prenatal care rate: 8.3%)	mild***	18.5	25.4	17.8
	moderate***	9.4	15.7	8.8
	severe	9.1	10.7	8.9
Women's behaviour and feelings during pregnancy:				
Involved [size: 3918] (poor prenatal care rate: 6%)	mild***	16.9	20.5	16.6
	moderate	8.1	9.4	8.0
	severe	8.7	9.0	8.6
Versatile [size: 5694] (poor prenatal care rate: 8.3%)	mild***	18.6	26.6	17.8
	moderate***	9.6	18.6	8.8
	severe	9.2	10.2	9.0
Aloof [size: 1105] (poor prenatal care rate: 15.6%) ^a	mild***	23.9	30.2	22.7
	moderate***	12.8	17.4	11.9
	severe	10.6	11.6	10.4
Experience of pregnancy:				
No [size: 3566] (poor prenatal care rate: 6.1%)	mild***	18.5	33.8	17.5
	moderate***	10.2	22.4	9.4
	severe***	11.2	17.8	10.8
Yes [size: 7151] (poor prenatal care rate: 9.4%)	mild***	18.5	23.1	18.0
	moderate***	8.9	13.8	8.5
	severe	8.1	8.2	8.1

Source: Present authors after ENP 2010. *** Significant difference of 1% at least of the proportion of health problems as a function of the mother's prenatal care. ^a This rate is more than 20% for the 129 women who say they did not want the child, who smoke more than 10 cigarettes per day, and who drink alcohol daily.

1.4.2 Estimates from main models

Table 1.3 gives estimated effect of prenatal care on outcome variables using a probit model. No significant impact of prenatal care could be identified for severe health problems observed at birth (line 5, Table 1.3).

However, proper prenatal care has a significant impact on health problems (lines 1 and 3, Table 1.3). Nevertheless consideration of observable characteristics (Table 1.3, columns 2 to 6) systematically reduces the marginal effect of prenatal care. Mild problems are associated with an increase of more than five percentage point probability (i.e. an average increase of more than 25 per cent) for newborn whose mothers failed to seek proper prenatal care. An increase of more than four percent-

age points (i.e. an average increase of more than 40 per cent) of the probability of newborn moderate health problems was observed. Considering observable variables decrease this effect, suggesting that these variables would be relevant for accounting for taking into account endogeneity bias. The results from estimating the model including all the explanatory variables that might affect the probability of prenatal care (column 6, [Table 1.3](#) and [Table 1.4](#)), showed that the mother's previous health problems, her risk-prone behaviour, obesity during pregnancy or her experience of pregnancy affect newborn health.

Table 1.3: Marginal Effect of prenatal care on the probability of newborn health problems

Severity of newborn health problem:	Model					
mild	-0.072** [-0.096 ; -0.047] ^b	-0.058** [-0.084 ; -0.033]	-0.055** [-0.080 ; -0.029]	-0.055** [-0.080 ; -0.029]	-0.053** [-0.079 ; -0.028]	-0.054** [-0.079 ; -0.028]
moderate	-0.059** [-0.077 ; -0.042]	-0.048** [-0.066 ; -0.031]	-0.047** [-0.065 ; -0.029]	-0.048** [-0.065 ; -0.030]	-0.045** [-0.063 ; -0.027]	-0.047** [-0.065 ; -0.029]
severe	-0.015 [-0.034 ; 0.004]	-0.012 [-0.031 ; 0.008]	-0.012 [-0.031 ; 0.008]	-0.012 [-0.031 ; 0.008]	-0.011 [-0.030 ; 0.009]	-0.012 [-0.031 ; 0.008]
Independent variables:						
socioeconomic		Yes ^a	Yes	Yes	Yes	Yes
psychological			Yes	Yes	Yes	Yes
health before pregnancy				Yes	Yes	Yes
risk behaviour during pregnancy					Yes	Yes
current pregnancy						Yes

Source: Present authors after ENP 2010. ** Marginal effects are significant at the 5% level at least. Estimates were obtained based on a probit model. ^a Explanatory variable used in the model. ^b 95% confidence interval. Reading: For the model without explanatory variables (a) the probability of newborn mild health problems was on average 7.2 percentage points lower for women with proper prenatal care.

[Table 1.5](#) gives results considering the endogeneity of prenatal care. These results agree with the marginal effect obtained with the simple model: prenatal care has a positive and significant effect on corpulence at birth both on mild and moderate infant health problems. The impact on severe infant health problems is not clear: with the IPTW method we observe a low but significant positive effect of proper prenatal and a no significant effect for the two other methods. Calculations of ATT and ATU values are very similar. Consequently, if women changed their attitude to prenatal care the results would be comparable except on severe newborn health problems. In this last case, the ATU is not significant, so if a woman with a poor prenatal care decides to have a proper prenatal care, the probability of her baby

Table 1.4: Estimation of the probability of newborn health problems

		Severity of newborn health problem		
		mild	moderate	severe
Intercept		-1.056***	-1.453***	-1.675***
Proper prenatal care	yes	-0.206***	-0.275***	-0.070
Socio-economic determinants				
Education	No degree - High school diploma	Ref.	Ref.	Ref.
	Post-graduate degree	-0.024	-0.062	-0.011
Age	Less than 25 years	0.004	0.003	0.123**
	[24, 35[	Ref.	Ref.	Ref.
	35 years and more	0.003	0.049	0.041
Nationality	French	Ref.	Ref.	Ref.
	European	-0.043	-0.115	-0.125
	African	0.042	0.006	0.040
	Other	0.045	0.049	0.158*
Maternal employment status	Employed	Ref.	Ref.	Ref.
	Out of the work force	-0.015	-0.097*	-0.066
	Unemployed	-0.017	-0.019	-0.024
Location: Paris	yes	-0.165	-0.097**	0.060
Family status	single	Ref.	Ref.	Ref.
	couple	-0.082	-0.160**	0.034
Household income band (€)	less than 2000	0.108***	0.093**	0.048
	[2000, 4000[	Ref.	Ref.	Ref.
	4000 and more	0.029	-0.024	0.004
Mutual supplementary insurance	yes	0.016	-0.056	0.007
Psychological determinants				
Close friends or family	low	0.052	0.090	0.029
Wanted pregnancy	yes	-0.138***	-0.015	0.020
Health before pregnancy determinants				
Health problem before pregnancy	yes	0.179**	0.093	0.211**
Obesity problem	yes	-0.014	-0.126**	0.055
Past pregnancy	no	0.073*	0.220***	0.275***
	yes, without problems	Ref.	Ref.	Ref.
	yes, with problems	0.043	0.110***	0.108***
Treatment for pregnancy	yes	-0.009	-0.001	0.055
Risk behaviour during pregnancy determinants				
Smokes during pregnancy	yes	0.143***	0.272***	0.083*
Drinks alcohol during pregnancy	yes	-0.011	-0.006	0.028
Information about pregnancy	yes	-0.006	-0.030	-0.054
Current pregnancy determinants				
Mother's weight	underweight	0.089**	0.191***	0.127***
	normal	Ref.	Ref.	Ref.
	overweight	-0.037	-0.209***	0.048
Health problems during pregnancy	yes	0.191***	0.230***	0.173***
Caesarean	yes	0.334***	0.411***	0.327***
The baby is a girl	yes	-0.011	-0.021	-0.096***

Source: Present authors after ENP 2010. *** Significant effects at 1%. ** Significant effects at 5%.

* Significant effects at 10%.

having a severe problem would be the same. Importantly, when not considering endogeneity, the marginal effect was shifted toward zero though this was significant

which is likely to be due to the unbalance between poor and proper prenatal care groups.

Table 1.5: Estimations of prenatal care effects on newborn health

Severity of newborn health problem	Method	ATE	ATT	ATU
Mild	PS Matching		-0.067 [-0.120 ; 0.008] ^a	
	IPTW	-0.071** [-0.107 ; -0.036]	-0.072** [-0.112 ; -0.034]	-0.090** [-0.122 ; -0.060]
	TMLE	-0.061** [-0.095 ; -0.027]	-0.06** [-0.095 ; -0.025]	-0.055** [-0.085 ; -0.024]
Moderate	PS Matching		-0.061** [-0.105 ; -0.007]	
	IPTW	-0.072** [-0.104 ; -0.043]	-0.074** [-0.107 ; -0.041]	-0.079** [-0.103 ; -0.055]
	TMLE	-0.062** [-0.091 ; -0.033]	-0.064** [-0.094 ; -0.034]	-0.049** [-0.075 ; -0.024]
Severe	PS Matching		-0.005 [-0.052 ; 0.035]	
	IPTW	-0.029** [-0.059 ; -0.001]	-0.031** [-0.058 ; -0.001]	-0.017 [-0.038 ; 0.003]
	TMLE	-0.023 [-0.05 ; 0.003]	-0.025 [-0.053 ; 0.003]	-0.01 [-0.031 ; 0.011]

Source: Present authors after ENP 2010. ** Effects are significant at the 5% level at least. ^a 95% confidence interval.
Abbreviations: PS Matching, Propensity Score Matching (1:1 ratio); IPTW, Inverse Probability Treatment Weighting; TMLE, Targeted Maximum Likelihood Estimation; ATE, Average Treatment Effect; ATT, Average Treatment Effect among the Treated; ATU, Average Treatment Effect among the Untreated

1.4.3 Estimates from stratified analyses

Table 1.6 gives results considering stratified analyses. These results show that the effect of prenatal care depends on the women behaviour. For both “low risk” and “high risk” women, prenatal care has no significant impact on the different outcomes of newborn health. Newborn health problems were associated with poor prenatal care concern “versatile” women, especially for mild and moderate problems. For this subpopulation of women, the effect of poor prenatal care on severe problem was not consistent among the different methods (severe problem, Table 1.6). Finally (Table 1.6), the experience of pregnancy is associated with different impact levels of poor prenatal care on newborn health problems. Firstly, prenatal care had no effect on the probability of transfer (severe problem) for women with experience of pregnancy only. Secondly, the effects for both mild and moderate problems were significantly stronger for women without any experience of pregnancy.

Table 1.6: Stratified analysis of prenatal care effects on newborn health

Severity of newborn health problem	Method	ATE	ATT	ATU
Low risk				
Mild	PS Matching		-0.047 [-0.149 ; 0.073] ^a	
	IPTW	-0.033 [-0.097 ; 0.026]	-0.033 [-0.096 ; 0.035]	-0.041 [-0.098 ; 0.014]
	TMLE	-0.042 [-0.096 ; 0.013]	-0.041 [-0.096 ; 0.014]	-0.042 [-0.095 ; 0.011]
Moderate	PS Matching		-0.013 [-0.098 ; 0.067]	
	IPTW	-0.032 [-0.084 ; 0.018]	-0.033 [-0.090 ; 0.015]	-0.011 [-0.050 ; 0.026]
	TMLE	-0.026 [-0.071 ; 0.018]	-0.028 [-0.073 ; 0.017]	-0.015 [-0.053 ; 0.023]
Severe	PS Matching		0.026 [-0.081 ; 0.090]	
	IPTW	-0.022 [-0.077 ; 0.030]	-0.023 [-0.076 ; 0.028]	0.000 [-0.038 ; 0.041]
	TMLE	-0.022 [-0.067 ; 0.023]	-0.023 [-0.069 ; 0.022]	-0.003 [-0.041 ; 0.035]
Others				
Mild	PS Matching		-0.083 [-0.159 ; 0.012]	
	IPTW	-0.102** [-0.156 ; -0.048]	-0.105** [-0.160 ; -0.050]	-0.101** [-0.143 ; -0.058]
	TMLE	-0.083** [-0.131 ; -0.034]	-0.082** [-0.132 ; -0.033]	-0.071** [-0.113 ; -0.03]
Moderate	PS Matching		-0.081** [-0.159 ; -0.017]	
	IPTW	-0.115** [-0.160 ; -0.065]	-0.117** [-0.173 ; -0.076]	-0.109** [-0.145 ; -0.073]
	TMLE	-0.102** [-0.144 ; -0.06]	-0.105** [-0.148 ; -0.062]	-0.082** [-0.118 ; -0.045]
Severe	PS Matching		-0.014 [-0.071 ; 0.045]	
	IPTW	-0.040** [-0.085 ; -0.001]	-0.043** [-0.084 ; -0.004]	-0.023 [-0.053 ; 0.006]
	TMLE	-0.037 [-0.074 ; 0.001]	-0.038 [-0.077 ; 0]	-0.01 [-0.04 ; 0.019]
High risk				
Mild	PS Matching		-0.065 [-0.228 ; 0.109]	
	IPTW	-0.051 [-0.142 ; 0.031]	-0.051 [-0.155 ; 0.037]	-0.094** [-0.179 ; -0.015]
	TMLE	-0.034 [-0.112 ; 0.043]	-0.031 [-0.111 ; 0.049]	-0.057 [-0.134 ; 0.021]
Moderate	PS Matching		-0.024 [-0.161 ; 0.076]	
	IPTW	-0.012 [-0.068 ; 0.041]	-0.009 [-0.064 ; 0.045]	-0.070** [-0.128 ; -0.009]
	TMLE	0.003 [-0.046 ; 0.052]	0.01 [-0.037 ; 0.058]	-0.028 [-0.093 ; 0.036]
Severe	PS Matching		-0.035 [-0.119 ; 0.086]	
	IPTW	-0.002 [-0.065 ; 0.049]	0.001 [-0.055 ; 0.050]	-0.007 [-0.067 ; 0.045]
	TMLE	-0.008 [-0.058 ; 0.042]	-0.009 [-0.059 ; 0.041]	-0.01 [-0.062 ; 0.041]

Source: Present authors after ENP 2010.

** Effects are significant at the 5% level at least.

^a 95% confidence interval.

Abbreviations: PS Matching, Propensity Score Matching (1:1 ratio); IPTW, Inverse Probability Treatment Weighting; TMLE, Targeted Maximum Likelihood Estimation; ATE, Average Treatment Effect; ATT, Average Treatment Effect among the Treated; ATU, Average Treatment Effect among the Untreated

1.4.4 Robustness analysis

Using the method developed by Ichino (Ichino, 2008), ATT was nullified when a hypothetical unobserved confounders is assumed to follow the same distribution, i.e distribution given the prenatal care status and newborn health outcome, as mutual supplementary insurance and family status. For these two variables, the odds ratio corresponding to the probability of proper prenatal care were 1.66 and 1.94, respectively, and were the highest values observed among the confounders tested (Table 1.7). Moreover, except for ATU for severe health problems, analysis of E-values for the different treatment effects for each outcome showed that E-values, on the odds ratio scale, above 2 would be required to explain away the effect. Altogether, the presence of a strong confounder would be required to nullify treatment effect (Table 1.8), as suggested by E-value analysis. This analysis suggested the robustness of the treatment effect observed for the different health outcomes.

Table 1.7: Sensitivity analysis using propensity score method on newborn moderate health problems

Variable	ATT	SE	Γ	Λ
Education	-0.047	0.023	0.893	1.534
Location	-0.054	0.023	0.593	0.951
Family status	-0.045	0.023	0.866	1.656
Mutual supplementary insurance	-0.044	0.024	0.869	1.943
Close friends or family	-0.050	0.024	1.000	0.584
Wanted pregnancy	-0.049	0.023	1.035	1.548
Health problem before pregnancy	-0.053	0.023	1.485	1.043
Obesity problem	-0.052	0.023	0.976	0.813
Treatment for pregnancy	-0.051	0.023	1.174	1.440
Smokes during pregnancy	-0.046	0.023	1.489	0.763
Drinks alcohol during pregnancy	-0.053	0.023	1.095	1.031
Information about pregnancy	-0.052	0.023	1.226	1.129

Abbreviations: ATT, Average Treatment among the Treated, SE, Standard Error; Γ the effect of the simulated unobserved confounder on newborn health problem, Λ , the effect of the simulated unobserved confounder on prenatal care.

Table 1.8: Sensitivity analysis (E-value analysis) using Inverse Probability Treatment Weighting

Severity of newborn health problem	Effect	E-value
Mild	ATE	2.42
	ATT	2.46
	ATU	2.10
Moderate	ATE	3.34
	ATT	3.43
	ATU	2.55
Severe	ATE	2.08
	ATT	2.13
	ATU	1.51

Abbreviations: ATE, Average Treatment Effect; ATT, Average Treatment Effect among the Treated; ATU, Average Treatment Effect among the Untreated.

1.5 Discussion

The aim of this paper was to highlight the link between prenatal medical care and newborn health. From the main analysis, the insignificant impact of prenatal care identified for severe health problems observed at birth might be explained by the fact that health problems could have been detected before birth, or that complications occurred during pregnancy. In that case, pregnant women may have sought prenatal care, and so would have underwent at the required minimum number of visits. This finding is consistent with that of Conway(Conway, 2005) who reported that monitoring has no impact on newborn health when pregnancy has been complicated (i.e. when the mother or the foetus experienced health problems during pregnancy). The findings on the effect of poor prenatal care on newborn health problems are also consistent with those reported by (Conway, 2005) who showed that, for normal pregnancies (without any particular problem during pregnancy), poor prenatal care is associated with lower birth corpulence.

Since ATT and ATU values were very similar, this suggested that if mothers who

had poor prenatal care had complied with the recommendations, the probability of newborn health problems would be comparable to pregnant women having sought proper prenatal care. Equivalently, if mothers who had sought proper prenatal care had decided not to follow these recommendations, newborn health problems would be comparable to that those who had poor prenatal care. This suggested that there is therefore a negative effect of poor prenatal care on the newborn corpulence, but there does not seem to be any difference in the perception of the risk related to newborn health problems that could be reduced by medical care between the two groups.

Women with risky behaviour (drinking and smoking) and those with bad psychosocial variables (isolation and no-wish to have a baby) had lower probability of having a proper health care (Ancelot, 2020). The relationships between variables relating to psychosocial aspects, health behaviour, and the level of adherence to prenatal medical care are complex. For instance, the last two categories of variables (e.g., drinking, substance abuse, smoking, observance or non-observance of pregnancy care commitment) can be part of a coping strategy adopted to respond to the stress due to psychosocial considerations (e.g., isolation, lack of social support, marital dissatisfaction, no-wish to have the baby to come) (Asselmann, 2020; Yali, 1999). Indeed, individuals, depending on their personality profiles, their life experiences, the social and economic resources they have, adopt different coping strategies for stress reduction when facing with health problems. Hence, we investigated whether there were a differential perception of prenatal care according to women behaviour. By definition, “low risk” women would adopt less risky behaviour during their pregnancy. In our study, the effect of prenatal care on newborn health problems was not significant (Table 1.6). This could be explained by this care by their clear perception of the weak risk of not ensuring proper prenatal care. On average, these women may be able with the help of their family, are able to manage their preg-

nancy without medical care. They have enough intrinsic motivation associated maybe with extrinsic motivation provided by their family. Similarly, “high risk” women did not show any effect of prenatal care on newborn health problems (Table 1.6). “High risk” women might be part of those who have denial-escaping oriented stress coping strategies. Unlike the “low risk” women, these women have scant regard for their pregnancy, and may compare to the disadvantaged expectant mothers in Sandner et al. study (Sandner, 2018). It would seem that the newborn health problems are related more to their negative behaviour during their pregnancy rather than to poor prenatal care. Either these women lack knowledge of the risk for their infant, or may feel unconcerned about healthcare in general. The type of prenatal care program under study would be therefore not properly suited to women with behaviour (e.g. not smoking) will change their prenatal care for the better. It could be monetary transfers –extrinsic motivation– like those implemented in Poland (Cygan-Rehm, 2020). In contrast, the effect of prenatal care among women in the “others” group was significant (Table 1.6). We could hypothesize that women in this group may be have emotion-support oriented stress coping strategies. Based on our results, prevention would therefore seem to be beneficial for newborn health. It may be possible that these women may use the visits for medical reasons but also to boost their willpower to smoke or drink less or to have a better general behaviour. This group may compare to those having an emotion-support oriented coping strategies as reported by Asselmann (Asselmann, 2020). Among these women, it might be possible that fewer prenatal medical care visits coupled with a specific psycho-emotional support would have a positive impact on newborn health. However, this needs to go hand in hand with properly accounting for potential stigma that may be caused by a potential intervention. For instance, social contact has been proven to account for this issue (Thornicroft, 2016). In this study, we accounted for different pre-disposing determinants: socio-economic, psy-

chological and health before the pregnancy. According to Andersen, health belief is also a component of predisposing factors (Andersen, 1995). We considered that women in this group may with proper enabling resources, such as social support or support by healthcare professionals, may increase the need perceived, leading to a better personal health practice and healthcare navigation as suggested by existing behavioural models (Andersen, 1995; Ryvicker, 2018).

However, this work presents several limitations. Only data among women having given birth to only one living child was captured, and thus we could not observe multiple births (*12 per mil*), newborn death (*9.2 per mil*), foetal deaths or terminated pregnancies because of congenital abnormalities (*9.5 per mil*). As a consequence, we may have underestimated the impact of prenatal care on newborn health problems. Moreover, information relating to mother’s health problems during pregnancy, and about the type and the quality of care that were provided during the delivery could not be used to compute the propensity score, since the information on the timing for the former was not available, and the latter would be influenced by prenatal care. Nevertheless, our results suggested a low impact of these variables on the effect observed (for example for mild problem, respectively -0.054 and -0.053). Finally, some factors could not be observed in this study, such as genetic factors and mental health related variables. However, the results of the robustness analysis suggested that the results are robust to the violation of the unobserved confounder hypothesis.

1.6 Conclusion

All theses results question the costly French prenatal medical care especially because its efficiency remains below that of other countries. This work revealed that purely medical prenatal care is ineffective to some degree for specific profiles of

pregnant women. Although the data cannot be used to measure the marginal effectiveness of a medical visit, the results showed, on average, the direct usefulness of a health practitioner seems to be challenged and in any event the marginal effect of a doctor's visit seems weak. In terms of perinatal health policy, this work supports specific actions at least for certain subpopulations of women with –very– low intrinsic motivation. This may involve targeted information campaigns or better psychosocial support. For instance, prenatal care for expectant mothers might be more customized and adapted, to enforce self-commitment during pregnancy, according to their socio-economic, behavioural, and psychological profiles, and to their lifecourse. Such customization might be translated for example by a reduction or an increase in the number of compulsory visits depending on their profiles. These additional visits could be performed by non-medical professionals. Rethinking perinatal care might make it more effective, and would probably reduce both the costs involved and the burden on healthcare professionals.

Chapter 2

Is there a link between self-reported unmet needs and healthcare expenditure?

2.1 Abstract

The objective of this study is to investigate the factors associated with self-reported unmet healthcare needs among individuals aged 65 and older living in France, and to determine whether healthcare expenditure and its determinants differ based on self-reported unmet needs. We utilize the 2012 Health and Welfare Survey data matched with health insurance information. Ambulatory care, so excluding inpatient care, expenditure are modeled using a regime-switching regression approach. Our findings highlight that social and behavioral inequalities are the primary factors influencing self-reported unmet needs. The determinants affecting healthcare expenditure are generally similar, regardless of individuals reporting unmet needs, except for pre-frailty and the number of pathologies. Surprisingly, we do not find a significant marginal effect of self-reported unmet needs on healthcare expenditure.

In our opinion, this calls into question the use of self-reported unmet needs as an indicator of access to care.

2.2 Introduction

Self-reported unmet needs is a frequently used measure of access to health care in Organization for Economic Co-operation and Development (OECD) countries. The European Commission reaffirms the importance of this indicator in the European Pillar of Social Rights (European-Commission & Secretariat-General, 2017). For health, the declaration stipulates that “everyone has the right to timely access to affordable, preventive and curative health care of good quality” and the core indicator measuring achievements is “self-reported unmet needs for medical care”. Ideally, a well-functioning health system should strive to ensure equitable access to care, both vertically (ensuring that the poorest individuals are not disadvantaged) and horizontally (avoiding disadvantages for populations at higher risk). In Europe, several studies have revealed significant inequalities in the consumption of specialized and preventive care, disproportionately affecting individuals with lower socioeconomic status (Deaton, 2002). However, the disparities are generally less pronounced when it comes to consultations with general practitioners, indicating relatively better access for the broader population (Devaux, 2012). However, disparities in access to healthcare persist, influenced by various factors such as social environment (including place of birth and childhood), employment status, and age. The relationships between social inequalities in access to healthcare, health outcomes, and environmental factors are complex, further complicated by the bidirectional relationship where health can also impact individual social conditions (Paraponaris, 2005).

There are various reasons why individuals may not have the opportunity to fulfill

their healthcare needs. The term “unmet needs” refers to the discrepancy between the healthcare that individuals deem necessary to address their health issues and the actual care they receive. Unmet needs can stem from financial factors such as the cost of healthcare, lack of coverage by supplementary insurance¹, out-of-pocket expenses, or insufficient resources. It can also be influenced by aspects related to the healthcare system, such as the availability of services, waiting times for care, or the distance between an individual’s residence and healthcare provider’s location (Herr, 2014). Unlike healthcare expenditure, which is objective and based on actual costs, unmet needs is a partially subjective concept as it relies on individual perception.

This raises the question of the relationship between self-reported unmet needs and the level of healthcare expenditure. One might intuitively expect that individuals who declare they forgo care, on average, have lower healthcare expenses compared to those who do not report unmet needs, assuming they have similar health conditions. If this hypothesis holds true, unmet needs would serve as an additional variable to explain healthcare expenditure and it is good indicator of the inadequacy of healthcare system to meet the needs of the population, as the European Commission claims. To our knowledge, no study has directly examined this question.

The aim of this research is therefore to examine the relationship between self-reported unmet needs and healthcare expenditure. The objective is so to investigate whether there are differences in average expenditure and the determinants that explain this expenditure based on individuals’ declaration of unmet needs.

These differences could be attributed to varying levels of willingness to pay or treat,

¹In France, almost all individuals are covered by compulsory public health insurance. On average, this covers 75% of healthcare costs, but private supplementary insurance can be taken out to supplement the statutory cover up to 100%. In certain circumstances, patients are covered for 100% of statutory costs by the public health insurance, notably when the insured suffers from one of the 30 specified long-term illnesses, see (Service-Public, 2023).

or factors related to the supply of care, although such information is not directly available in this study. Additionally, since certain characteristics influence both healthcare expenditure and unmet needs, for example preferences, it is important to recognize that renunciation may be endogenous and should be estimated simultaneously with expenditure. Therefore, this study analyzes self-reported unmet needs and healthcare expenditure concurrently among individuals aged 65 years and older. We select the older adults because we assume that all needed health care in the past 12 months, whether preventive or curative. This approach will contribute to a better understanding of their healthcare utilization behavior. We do not find a significant marginal effect of self-reported unmet needs on healthcare expenditure. This calls into question the use of self-reported unmet needs as an indicator of access to care.

2.3 Materials and Methods

2.3.1 Data

In this study, we use the 2012 Enquête Santé et Protection Sociale² (ESPS) (Céant, 2014) matched with data from the Échantillon Généraliste de Bénéficiaires (EGB). The EGB is a representative sample of the population covered by the French public health insurance system containing data on health care consumption and total expenditure (reimbursement by the public coverage and the supplementary insurance plus out-of-pocket expenses). The EGB, representative of 95% of the French population, covers 599,544 individuals in 2012. Based on this sample, we are only provided with a sub-sample of individuals drawn at random; note that these individuals and their family members are eligible for the ESPS survey. In total, data

²We are unable to use more recent data because it could not be matched to healthcare expenditure. Note that the French healthcare system and population have changed very little since 2012.

for 8,413 households representing 23,047 French residents are available. The sample of persons aged 65 years or over, after merging with the EGB database, includes 1,096 persons. The merged database contains information on self-perceived health status, public and private supplementary health insurance coverage, visits to a doctor, consumption of medical goods and services, and reasons for unmet needs. In addition to these health data, all the usual socio-economic information is included.

2.3.2 Variables

Dependent variables

Unmet needs Unmet health needs is taken in a broad sense, i.e., regardless of reason and specialty. Therefore, is considered to have unmet needs an individual answered yes to at least one of the six questions on health care needs (the questions are given in the Appendix). Perceived unmet needs can be related to financial problems, distance or delay and can concern all types of care.

Ambulatory health expenditure In the ESPS, ambulatory health expenditure consists of: 1) visits to general practitioners; 2) visits to specialists; 3) visits to dentists; 4) services of nurses; 5) services of physical therapists; 6) services of other auxiliaries; 7) biomedical analyses; 8) consumption of health resources: pharmaceuticals, health equipment, optics, prostheses, and transport; and 9) emergency visits that did not result in hospital admission. Expenditure, in euros, is log-transformed. All individuals in the sample have strictly positive healthcare expenditure. This means that they all have consumed health care at least once during the past year³.

³Remember that we chose to consider only people over 65 because we thought they all had a positive healthcare expenditure. This is confirmed in our sample.

Explanatory variables

Frailty Based on the study carried out by Sirven (Sirven, 2017), a frailty score is constructed using five dimensions (Fried, 2001; Fried, 2004): slowing of walking speed, fatigue or poor endurance, muscle weakness, sedentary lifestyle or low physical activity, involuntary weight loss. According to this scale, one point is attributed for each criterion reported, the frailty score is therefore between 0 and 5. From this, three profiles are usually defined: robust (score equal to 0), pre-frailty (score equal to 1 or 2), frailty (score strictly greater than 2).

Limitation in activities of daily living This information is characterized by an indicator taking the value of 1 when at least one of the following functional limitations (ADLs) was reported: difficulties with feeding, sitting/lying, dressing, showering/bathing, and toileting.

Other variables Socio-economic variables: age (in classes); gender; living with a partner; social life (participates in collective activities: association, choir, etc.); level of education (primary, secondary, higher); parents' level of education (primary, higher); socio-professional category of the last job (middle or higher management, self-employed, manual, or clerical worker, not working); area of residence (big city, suburbs, other); experience of isolation (the person felt alone during one or more periods of his/her life); monthly income level dichotomized using a cut-off value of 1500 euros (more or less than the average pension in France); supplementary insurance (private, CMU⁴). Socio-economic determinants play a significant role in unmet healthcare needs. Factors such as gender, age, and education level, as highlighted by the existing literature (Dourgnon, 2012; Fleurbaey, 2009; Trannoy, 2010), can contribute to financial difficulties and subsequently lead to

⁴The CMU (Couverture Maladie Universelle) in France provides basic services to the poorest families.

unmet needs. Lack or low levels of health coverage, limited income, out-of-pocket expenses, and overall precarious financial situations, particularly among disadvantaged social classes, have been identified as contributing factors to unmet needs (Allin, 2010; Berchet, 2013; Bongers, 1997; Després, 2011; Dourgnon, 2012; Lapinte, 2021; Raynaud, 2005). Efforts to reduce financial exclusion have been made, such as the implementation of universal or near-universal coverage, like the CMU. Dourgnon (Dourgnon, 2012) demonstrate that CMU reduces unmet needs. However, certain types of healthcare, such as optical and dental care, are only partially covered, despite recent measures to improve coverage in France⁵ (OCDE, 2017b). Behavioral variables included alcohol consumption (never, less than once a day, every day); tobacco consumption (more than 10 cigarettes a day, less than 10 cigarettes a day, no longer smokes, never smoked) ; attitude towards risk, the scale varies from 0 (cautious person who tries to limit the risks of life as much as possible and looks for a well-ordered life, without surprises) to 10 (person attracted by adventure, who looks for novelty and challenges, likes to take risks), the individuals who answered at least 7 are qualified as adventurous; attitude towards the future, the scale varies from 0 (individual who lives from day to day and takes life as it comes, without thinking too much about tomorrow or projecting into the future) to 10 (individual concerned about his or her future, even if it is far away, who has strong ideas about what he or she would like to be or do in the future), the individuals who answered at least 7 are qualified as anxious⁶. Behavioral and medical determinants also play a role. Individual preferences for care, attitudes towards the body and illness, and lifestyle choices can affect the decision to forego care (Bazin, 2006; Berchet, 2013; Dourgnon, 2012). Risky behaviors such as alcohol and tobacco

⁵In France, since January 1, 2020, the “zéro reste à charge” (zero out-of-pocket) measure has been implemented in the healthcare sector. Specifically, in the optical sector, professionals are now required to include fully reimbursed glasses and lenses in their price quotations but also for dental care.

⁶The dichotomization was performed using a classification and a regression tree - CART.

use, cannabis use, obesity, as well as a strong preference for immediate gratification, contribute to renunciation (Jusot, 2013; Mackenbach, 2006).

Regarding health-related variables, to the activities of daily living already described, we add an indicator taking the value 1 when at least one of the following chronic diseases is declared (asthma, bronchitis, heart attack, coronary problem, hypertension, stroke, arthritis, back pain, neck pain, diabetes, allergy, cirrhosis, urinary disorders and depression). Unmet needs increase with worsening health status or the presence of chronic diseases (Bazin, 2006; Després, 2011). The presence of multiple diseases (polycomorbidity) is positively associated with unmet needs, as the likelihood of not seeking care increases with the number of diseases (Krutilová, 2016).

2.3.3 Health expenditure: switching model

The model

One of the objective is to identify whether to report unmet needs have an effect on health expenditure and to study the determinants of this expenditure according to whether the individual declares unmet needs or not. To answer this, a model integrating an indicator of unmet needs in health expenditure equation could be estimated. The estimation of two equations, one for those who report to have given up and another for those who have not, could meet the second objective. However, these answers will only be satisfactory on one condition: the assumption that self-reported unmet needs are an exogenous variable. The health needs that an individual declares to have renounced present, a priori, an endogeneity since the choice to consume health care is voluntary and based on the needs perceived by each individual.

To deal with this endogeneity problem, we conduct an estimation with instrumental variables (IV). A first method consists in estimating simultaneously the probability

of unmet needs and the effect of unmet needs on healthcare expenditure (maximum likelihood) or in estimating two equations, one for unmet needs and the other for healthcare expenditure, correcting for unmet needs (double ordinary least squares). Either of these models can meet our first objective (to identify whether giving up care has an effect on health care spending) but does not allow us to identify whether the determinants of health care spending have different effects between people who declare unmet needs and those who do not. A second approach is to adopt a switching model, with the two regimes defined by the selection equation based on unmet needs. Three equations (probability of unmet needs, expenditure for those who declare unmet needs and those who do not) are estimated simultaneously by full information maximum likelihood (FIML⁷). This approach makes it possible to take into account the potential difference in ambulatory care consumption behavior between individuals who have declared unmet needs and those who have not (Carter, 2005). But also, to compare the expected expenditure between those who renounce and those who do not, and to determine, via counterfactuals, what the expenditure would be if individuals changed their behavior (regime), which the first method does not allow.

The selection equation linked to unmet needs is characterized by a dichotomous variable R_i which takes the value 1 when the individual i declares unmet needs and 0 otherwise. The renunciation ($R_i = 1$) is determined by a latent variable $R_i^* = Z_i \alpha + \eta_i = X_i \alpha_x + \mathcal{I}_i \alpha_{\mathcal{I}} + \eta_i$, positive, with $Z_i = (X_i \mathcal{I}_i)$. This variable depends on the observed individual characteristics X_i , on the instrumental variables $\mathcal{I}_i$, on the vectors of parameters associated with these two sets of characteristics α_x and $\alpha_{\mathcal{I}}$, and on a random measurement error η_i assumed to follow a reduced centered normal law.

⁷An alternative method would be to apply the two-step estimation procedure (Maddala, 1983), this method is less efficient than FIML and “poorly performs” if the multicollinearity between the explanatory variables of the selection equation and those of the expenditure equation is strong.

The two equations associated with the regime change are defined by $Y_{1i} = X_i \beta_1 + \epsilon_{1i}$ and $Y_{0i} = X_i \beta_0 + \epsilon_{0i}$. Where Y_{1i} and Y_{0i} represent the logarithm of -ambulatory-healthcare expenditure for individuals with and without declared unmet needs respectively, β_1 and β_0 are for each subgroup the parameter vectors associated with the vector X_i . The two equations for the two subgroups are assumed to be independent. The error term, η_i , is correlated with the expenditure error terms, ϵ_{1i} and ϵ_{0i} . The correlation coefficients are $\sigma_{1\eta}$ and $\sigma_{0\eta}$, respectively. The expectation of the errors conditional on the selection of the subgroups is non-zero and given in the Appendix.

To correct for the potential selection bias associated with unmet needs, two instrumental variables are introduced into the model. The first is an indicator measuring the financial difficulties encountered by the individual in the past⁸. One can think that if the individual has regularly experienced financial difficulties, he or she has had to forego care during his or her life and therefore potentially continues to forego care because his or her health stock is low or simply out of “habit”. These individuals have a greater preference for the present and are a priori more inclined to postpone care that would have positive future consequences. The second is a macroeconomic variable, the poverty rate, which corresponds to the proportion of people whose income is below the poverty line, i.e., 60 percent of the median income in the territory under consideration, at the county⁹ level. This variable is a proxy for the availability and the quality of health services and the cost to access them. To be valid, instruments must have an effect on the selection equation (probability of unmet needs) but not on the outcome (healthcare expenditure); these two conditions are verified (Table 2.5 and Table 2.6 in the Appendix).

⁸The question asked is: have you had times in your life when you have not been able to pay your bills, rent, credit repayments, etc. . .

⁹Département in French.

Treatment and heterogeneity effects

The regime-switching model estimates four conditional expenditure expectations. Two relate to individuals reporting or not reporting unmet needs and two are associated with counterfactuals (those who report unmet needs if they have not reported any, and vice versa). From these conditional expectations, we estimate the various effects associated with unmet needs (for more details see for example Heckman (Heckman, 2001) and Carter (Carter, 2005)):

- The average treatment effect on treated (ATT) defined as the difference between (2.5) and (2.7) :

$$ATT = \mathbb{E}[Y_{1i}|R_i = 1] - \mathbb{E}[Y_{0i}|R_i = 1] = X_{1i}(\beta_1 - \beta_0) + (\sigma_{1\eta} - \sigma_{0\eta})\lambda_{1i}. \quad (2.1)$$

- The average treatment effect on untreated (ATU) defined as the difference between (2.8) and (2.6) :

$$ATU = \mathbb{E}[Y_{1i}|R_i = 0] - \mathbb{E}[Y_{0i}|R_i = 0] = X_{0i}(\beta_1 - \beta_0) + (\sigma_{1\eta} - \sigma_{0\eta})\lambda_{0i}. \quad (2.2)$$

- The effect of baseline heterogeneity (BH₁) for individuals who give up, is given by the difference between (2.5) and (2.8) :

$$BH_1 = \mathbb{E}[Y_{1i}|R_i = 1] - \mathbb{E}[Y_{1i}|R_i = 0] = (X_{1i} - X_{0i})\beta_1 + \sigma_{1\eta}(\lambda_{1i} - \lambda_{0i}). \quad (2.3)$$

- The effect of baseline heterogeneity (BH₀) for individuals who do not give up, is given by the difference between (2.7) and (2.6) :

$$BH_0 = \mathbb{E}[Y_{0i}|R_i = 1] - \mathbb{E}[Y_{0i}|R_i = 0] = (X_{1i} - X_{0i})\beta_0 + \sigma_{0\eta}(\lambda_{1i} - \lambda_{0i}). \quad (2.4)$$

The (2.1) and (2.2) relationships measure the effect of unmet needs on healthcare

expenditure, while the (2.3) and (2.4) relationships instead measure the effect of differences in characteristics (observable or not) on expenditure.

Two sets of robustness tests of the estimated effect of unmet needs on healthcare expenditure are performed. The first set of tests focuses on the estimation methods¹⁰. Three alternative models to the regime-switching model are estimated (see the Appendix), with Lewbel’s method and two matching methods: propensity score matching, and inverse treatment probability weighting (IPTW). The second set focuses on the definition of the unmet needs variable.

2.4 Results

2.4.1 Descriptive analysis

The sample includes 1,096 individuals people over 65 years old for whom data were available in the ESPS 2012 database and in the EGB database. In this database, 27.6% of the individuals declare unmet needs, see Table 2.1. The most frequent unmet needs concern optical and dental care for financial reasons. Table 2.7 presents a descriptive summary of this sample. More than half of the sample is under 75 years old, and one-third is concerned about the future. Of the individuals in the sample 62.6% report at most one medical condition and 83.6% have no ADL. Regarding frailty, most individuals are classified as robust (52.1%) or pre-frail (34.1%). Concerning supplementary insurance, almost all the individuals in the sample declared having it (93.7%) and very few individuals benefited from the CMU (1.6%). Individuals who declare unmet needs are more likely to have experienced financial problems in the past (44.6% vs. 19.8%), more experience of isolation (21.8% vs. 12.4%) and the proportion of women is higher (62.4% vs. 54.9%). These indi-

¹⁰All statistical analyses were performed using R Statistical Software (version 4.0.4; R Foundation for Statistical Computing, Vienna, Austria).

viduals also have a lower proportion of high-income earners (34.7% vs. 45.0%). In addition, the proportion of individuals not living with a partner is higher (46.9% vs. 39.5%). We also observe a worse reported health status: the proportion of individuals with at least one pathology is higher (75.6% vs. 66.1%), the proportion of individuals with at least one ADL is higher (20.1% vs. 15.0%) and the proportion of robust individuals is lower (45.2% vs. 54.7%). Finally, fewer individuals have supplementary insurance when they report unmet needs (88.4% vs. 95.7%).

Table 2.1: Statistics on self-reported unmet needs

	Number of observations	% of the sample
Individuals declaring unmet needs	303	27.6
Type of unmet needs		of the subsample
Dental for financial reasons	177	58.4
Optical for financial reasons	108	35.6
Medical consultation for financial reasons	28	9.2
Other types of care for financial reasons	41	13.5
For long appointment delays	82	27.1
For distance or transportation problems	29	9.6

Source: Enquête santé et protection sociale (ESPS) matched with Échantillon Généraliste de Bénéficiaires (EGB), 2012.

Notes: 303 individuals report at least one unmet need or 27.6% of the sample. 58.4% of those reporting at least one unmet need report dental unmet need.

2.4.2 Regime-switching regression

To account for the endogeneity of unmet needs, a regime-switching regression is performed. This model allows us to estimate the determinants that have an effect on the probability of declaring unmet needs and to measure the effect of these determinants on healthcare expenditure according to whether individuals have declared unmet needs (see [Table 2.2](#)). Our results show that the probability of declaring unmet needs is lower as age increases, for men, for workers/employees, for individuals with supplementary health insurance or CMU, for individuals living in suburbs and

for those with high incomes. On the other hand, this probability is greater for those who smoke more than ten cigarettes a day, those who have experienced loneliness or financial problems in the past and those who are worried about the future.

Table 2.2: Estimates using endogenous switching regression

Variable	Class	Unmet needs		Healthcare expenditure			
		Estimate	SE	without unmet needs	SE	with unmet needs	SE
Gender (Ref. Female)	Male	-0.22**	0.11	0.13	0.08	0.01	0.13
Age (Ref. 65-69)	70-74	-0.16	0.12	0.17*	0.09	0.19	0.15
	75-79	-0.21*	0.13	0.21**	0.10	0.11	0.15
	80-84	-0.37**	0.15	0.28**	0.12	0.32	0.20
	85+	-0.54***	0.18	0.17	0.14	0.01	0.23
Socio-professional category of the last job (Ref. Managers)	Inactive	-0.06	0.24	-0.18	0.18	0.03	0.27
	Self-employed	-0.16	0.15	-0.01	0.11	0.07	0.18
	Worker or employee	-0.22*	0.13	-0.03	0.10	0.15	0.17
CMU	Yes	-0.58*	0.35	0.18	0.31	1.05***	0.40
Supplementary insurance	Yes	-0.51***	0.18	0.36*	0.19	0.54***	0.20
Living with a partner	Yes	-0.12	0.10	-0.13	0.08	0.00	0.11
Daily alcohol consumption (Ref. Never)	Less than one glass	-0.08	0.10	-0.20**	0.08	-0.22*	0.12
	One glass or more	-0.19	0.12	-0.23***	0.09	-0.22	0.15
Smoking status (Ref. Do not smoke)	Smoking cessation	0.10	0.11	0.09	0.09	0.21	0.14
	Less than 10 cigarettes a day	0.01	0.17	-0.09	0.13	-0.02	0.19
	More than 10 cigarettes a day	0.49**	0.25	0.17	0.25	-0.29	0.26
Risky attitude	Yes	0.13	0.12	-0.02	0.10	0.05	0.15
Education (Ref. Primary education)	Secondary	0.01	0.10	0.05	0.08	-0.04	0.13
	Higher	0.25	0.17	0.15	0.14	-0.02	0.20
Experience of seclusion	Yes	0.20*	0.12	0.02	0.11	-0.14	0.13
Social life	Yes	-0.14	0.12	-0.04	0.10	0.15	0.14
Living area (Ref. Big city)	Suburbs	-0.21*	0.11	0.08	0.08	0.12	0.14
	Other	-0.08	0.11	0.04	0.08	0.03	0.13
ADL	Yes	0.08	0.14	0.20*	0.11	0.13	0.15
Number of pathologies (Ref. None)	One	0.04	0.11	0.31***	0.08	0.21	0.14
	More than one	0.18	0.11	0.51***	0.09	0.51***	0.15
Frailty (Ref. Robust)	Prefrail	0.05	0.10	0.35***	0.08	0.17	0.13
	Frail	0.19	0.16	0.64***	0.13	0.55***	0.18
High income	Yes	-0.29***	0.10	0.03	0.08	0.28**	0.14
Concern about the future	Yes	0.21**	0.09	-0.01	0.07	0.04	0.11
Past financial problems	Yes	0.60***	0.10				

continued on next page

Table 2.2 : continued

Variable	Class	Unmet needs		Healthcare expenditure			
		Estimate	SE	without unmet needs		with unmet needs	
		Estimate	SE	Estimate	SE	Estimate	SE
County poverty rate		0.04***	0.01				
Covariance	$\sigma_{0\eta}; \sigma_{1\eta}$			-0.25*	0.14	-0.76***	0.07

Source: Enquête santé et protection sociale (ESPS) matched with Échantillon Généraliste de Bénéficiaires (EGB), 2012.

Note: For each estimated relationship, the first column is the estimated coefficient (significance level: * 10%, ** 5%, *** 1%) and the second column the standard errors. Healthcare expenditure is in logarithm.

With respect to healthcare expenditure, some variables have the same effect whether or not individuals reported unmet needs: having supplementary insurance, having at least two medical conditions, and being frail increase expenditure, and having less than one drink of alcohol per day decrease expenditure. Some other variables have a different effect on expenditure depending on whether people have declared unmet needs. Being between 70 and 84 years old, having at least one ADL, and having only one pathology increase the expenditure of those who do not declare unmet needs and consuming more than one drink per day decreases it. Being eligible for CMU or having a high income increases the expenditure of individuals reporting unmet needs. The correlation coefficient between the error term of the expenditure and unmet needs equations are negative, insignificant for individuals who have not unmet needs and significant for the others. Moreover, the equality at zero of the two correlation coefficients is rejected, suggesting the presence of endogeneity.

Table 2.3 presents the effects of treatment and heterogeneity, as well as the conditional expectations considering the actual and counterfactual conditions. We do not identify a significant effect of unmet needs in either subpopulation or heterogeneity in characteristics.

Table 2.3: Conditional Expectations, treatment and heterogeneity effects of unmet healthcare needs

	Population/Outcome	Estimate	CI(95%)
Healthcare expenditure	without unmet needs (Observed)	7.47	[7.36 ; 7.58]
	with unmet needs (Observed)	7.31	[7.08 ; 8.17]
	without unmet needs (Counterfactual)	7.30	[6.89 ; 9.05]
	with unmet needs (Counterfactual)	7.95	[7.19 ; 8.52]
Effect of unmet needs	without unmet needs: ATU	-0.17	[-0.59 ; 1.57]
	with unmet needs: ATT	-0.64	[-1.28 ; 0.20]
Base heterogeneity	without unmet needs: BH ₀	-0.48	[-1.05 ; 0.23]
	with unmet needs: BH ₁	-0.01	[-0.21 ; 0.90]

Source: Enquête santé et protection sociale (ESPS) matched with Échantillon Généraliste de Bénéficiaires (EGB), 2012.

Note: Healthcare expenditure is log transformed. CI: Confidence Interval.

2.4.3 Robustness tests

Since, on the one hand, it is always difficult to justify empirically the choice of instruments (in this case, the financial problems experienced in the past and the county poverty rate) and, on the other hand, the results may be sensitive to the chosen distribution of health expenditure (Hasebe, 2018), alternative models are considered to test the robustness of ours results.

When instruments are not available or are questionable, Lewbel's method is an alternative method of estimation within a regression model. The coefficient associated with unmet needs is not significant¹¹ (see Table 2.9). Therefore, the results regarding the effect of unmet needs on healthcare expenditure are consistent with the regime-switching regression analysis. Matching methods are then tested, see Table 2.4. Regardless of the matching method considered (propensity score¹² or IPTW), the ATT and the ATU are not significant. Sensitivity analysis of the conditional independence assumption (CIA) confirms these results (see Table 2.8).

The four estimation methods used thus lead us to the same result: declared unmet

¹¹For comparison, maximum likelihood estimation of the two-equation instrumental variable model is added. The coefficient associated with the unmet needs variable is not significant.

¹²The matched sample is described Table 2.10.

needs does not seem to have an impact on healthcare expenditure.

To complete this study of the sensitivity of the results, alternative definitions of unmet needs and of healthcare expenditure are considered (see [Table 2.4](#)). Alternative definitions do not show a significant effect: the impact on dental and optical expenses of unmet dental and optical needs on the one hand, and unmet needs for financial reasons or for appointment delays and transportations problems on the other¹³.

Table 2.4: Robustness tests

		Effect	CI (95%)
Alternative models			
Propensity score matching	ATT	-0.03	[-0.23 ; 0.17]
	ATU	-0.01	[-0.23 ; 0.21]
IPTW	ATT	-0.11	[-0.25 ; 0.03]
	ATU	-0.13	[-0.29 ; 0.03]
Alternative definitions of unmet needs and of healthcare expenditure			
Unmet needs effect (dental and optical only) on the dental and optical expenses ^a	ATT	-83.67	[-165.67 ; 50.51]
	ATU	-56.41	[-148.24 ; 175.12]
Unmet needs effect (dental and optical excluded) on healthcare expenditure (dental and optical excluded)	ATT	-0.04	[-0.48 ; 0.31]
	ATU	0.15	[-0.67 ; 1.48]
Unmet needs for financial reasons effect on healthcare expenditure	ATT	-0.01	[-2.25 ; 1.00]
	ATU	-2.97	[-4.80 ; 27.77]
Unmet needs for appointment delays or transportation problems effect on healthcare expenditure	ATT	0.01	[-1.41 ; 1.56]
	ATU	9.06	[-5.14 ; 69.17]

Source: Enquête santé et protection sociale (ESPS) matched with Échantillon Généraliste de Bénéficiaires (EGB), 2012.

Note: The values presented are in logarithm except for ^a which are in euros because some expenses are equal to 0. CI: confidence interval.

2.5 Discussion

Our study aims to uncover the factors associated with self-reported unmet healthcare needs among the French older adults population and to elucidate the disparities in access to care between individuals who report unmet needs and those who

¹³For reasons of sample size, other combinations are not tested.

do not. Our findings indicate that several factors play a significant role in the declaration of unmet needs, including gender, age, smoking status, have taken out supplementary health insurance, income level, and concerns about the future. When examining healthcare expenditure, we find that certain determinants may differ depending on whether individuals report unmet needs. However, irrespective of the estimation method employed, we do not observe any significant marginal effect of self-reported unmet needs on healthcare spending.

Regarding unmet needs, we identify some determinants that are consistent with the literature. Male and older have a lower probability of reporting unmet needs, which confirms the results of Despres (Després, 2011) and Celant (Célant, 2014) for example. Coverage by supplementary health insurance or CMU is negatively associated with reporting unmet needs. Previous studies have provided evidence of the negative relationship between having supplementary health insurance and reporting unmet needs (Doorslaer, 2004; Dourgnon, 2012; Raynaud, 2005). On the other hand, the fact that one is more likely to report unmet needs when one has experienced financial problems in the past has not, to our knowledge, been demonstrated. Lapinte (Lapinte, 2021) have only established the link between poverty and unmet needs for care. Two explanations can be considered. On the one hand, people who have experienced financial difficulties in the past are more cautious about spending and therefore sensitive to possible remaining expenditure. On the other hand, they have a relatively low health stock because they have had to forego care in the past and they continue to do so because it would be too expensive now to treat (dental care for example). In addition, people with higher income levels report fewer unmet needs, which is consistent with the existing literature (Allin, 2010; Fleurbaey, 2009). Similarly, the impact of tobacco use has not been well documented in the literature on unmet needs. Our results suggest that individuals with a smoking profile (more than 10 cigarettes) would be more likely to delay access to the health care system

given their propensity to exhibit riskier behavior¹⁴. It is also possible that these individuals try to avoid the healthcare system for fear that their behavior will be stigmatized. Our results do not show the standard effect of polypathology (increase in unmet needs with the number of diseases (Krůtilová, 2016)). This result may be related to the relative age of our sample. This population has two opposing attitudes to the deterioration in its state of health: some people tend not to declare unmet needs because they see this deterioration as inevitable, while others declare unmet needs because they would like to receive more care. We show also that people who are worried about their future report more unmet needs. This information is generally not taken into account in the literature. We could hypothesize that for these people, the fear of the future is linked at least in part to the fear of illness or deterioration in health status. They would have an “insatiable” need to be reassured by healthcare providers, which leads them to declare unmet needs. Since the health care system does not allow them to obtain this care, their expenditure is equivalent to that of those who do not want this additional care.

In line with the work of Sirven (Sirven, 2017), we show the importance of frailty in terms of demand and expenditure on care. These authors put forward two different hypotheses: either an individual becomes frail as a result of heavy medical treatments related to serious illnesses, or a frail individual is more sensitive to his or her health status, even without a diagnosis. Our results suggest that health care consumption increases progressively with the degree of frailty and the number of medical conditions in individuals who do not report unmet needs, which is consistent with the literature (Comans, 2016; Li, 2020; McDonald, 2010). In contrast, among those with unmet needs, being pre-frail and having only one pathology is not associated with increased health care spending. Two explanations are possible. Either these individuals tend to overestimate their poor health status or they forgo

¹⁴This result is also observed for pregnant women, who tend to forgo visits during pregnancy when they smoke (Ancelet, 2020).

care when their health status is slightly deteriorated. Some of these people may consider the deterioration of their health as inevitable, which would negatively influence the search for care. It should be noted that healthcare expenditure decreases with higher alcohol consumption among those not reporting unmet needs. Alcohol consumption is known to be negatively associated with healthcare expenditure among the older adults (Mukamal, 2006).

The two main limitations of our study are that our sample, although representative, is too small to be subdivided into substantial subgroups. Secondly, we have no panel data with which to examine the potential transitions of certain individuals declaring unmet needs to the group of individuals declaring no unmet needs, and vice versa. These two limitations do not allow us to validate the intuitions we are going to give in an attempt to explain the surprising result, there is no significant difference in terms of healthcare expenditure between individuals who declare unmet needs and those who do not, that we obtain.

Assuming that all the individuals who declare unmet needs are medically justified in doing so. Medical studies show, particularly in France, that there are elderly people who objectively do not receive the care they need, and that they are not necessarily aware of this, see for example Maille (Maille, 2017) on the older patients' perception of their oral health status in France. There are therefore individuals in the group of those who declare no unmet need who are not receiving the amount of care deemed necessary by healthcare professionals. The latter, given our hypothesis, must be more numerous than those declaring unmet needs (27.6%) to obtain our result. Otherwise, we would find that the average expenditure is higher among those who declare no unmet need. That at least two-thirds of France's elderly population do not receive the care they need does not seem realistic to us. Therefore, we must admit that a significant proportion of those who declare unmet needs have no reason to do so from a medical point of view.

Looking at individuals who do not declare any unmet needs, we notice that the older they are, the frailer they are, the more pathologies they declare, the higher their healthcare expenditure. This result is not surprising. On the other hand, for individuals declaring unmet needs, age has no impact on their expenditure, and only a state of frailty or the presence of at least two pathologies seems to influence their healthcare expenditure, which is counter-intuitive. As far as age is concerned, we might think that some individuals, no doubt among those whose health is beginning to deteriorate, leave the group declaring unmet needs and move into the other group, as age advances. But if this were the only explanation, it should result in a significantly higher average expenditure for those who do not declare unmet needs. The level of fragility is declarative, as are unmet needs. It may be that some individuals declaring unmet needs overestimate their level of frailty. As the coefficient linked to supplementary insurance is highly significant, which is not the case for the other group, it is possible that they have a higher (ex post) moral hazard overconsumption. Note that the income effect on healthcare expenditure supports this explanation, this effect being significant only for the group that declares giving up. The same undoubtedly applies to the number of pathologies. For each reported pathology, there are several levels of severity but we don't know the severity levels. It is even possible that some of the individuals who declare they are giving up are hypochondriacs. According to a survey (Ifop & Capital-Image, 2014), there are 8.5 million hypochondriacs in France, or more than 12% of the French population. To a lesser extent, the results obtained for the ADL variable support this intuition. To sum up, our intuition suggests that, in the group declaring unmet needs, a proportion of individuals, over time, see their health deteriorate and change group. Those who continue to declare unmet needs after the age of 70 overconsume more in terms of health, while overestimating their poor health. Tseng (Tseng, 2015) show that in a sample of patients with eye floaters (myodesopia), slightly less than half show

doctor-shopping behavior even though in most cases are a benign occurrence without any long-term complication. They find that women and non-myopia patients were significantly related with frequent attendance and doctor switching. We too, like many other studies, show that gender has an effect on the reporting of unmet needs. But since gender has no effect on health expenditure, we feel it safer to consider that there is a hidden variable conditioning the declaration of unmet needs, no doubt linked to preferences. This type of preferences is more common among women than men.

What we have just discussed attempts to explain why expenditure is not significantly different between the group declaring to give up and those not declaring to do so. However, it does not explain why part of the population declares renunciation. For those who change groups as they get older, as their health deteriorates, they have to spend more time and money on healthcare. This compulsory transition from one consumption bundle to another can be difficult to accept. As for those who remain ‘permanently’ dissatisfied, if we accept that at least some of them overconsume in terms of healthcare, we can understand why they declare giving up. Although the French system is generous, a remaining out-of-pocket expense persists, particularly for dental and ophthalmological care, further hindering their ability to overconsume these types of care.

That there are objectively unmet healthcare needs in France is not called into question by this work, see for example Herr (Herr, 2014). What we question is the use of self-reported unmet needs as the main indicator for tackling this problem. It should be noted that the use of this indicator has had political repercussions in France. The 2017 presidential election candidate, Emmanuel Macron, proposed full reimbursement for glasses, dental care and hearing aids (Casassus, 2017). Once elected, he made good on this promise, and application of the measure began on January 1, 2020. If, as Maille (Maille, 2017) show, the problem is that a significant

proportion of elderly people are unaware that their health is deteriorating, this policy could increase public spending because of the moral hazard problem, without reducing the prevalence of ‘real’ unmet needs. It’s worth remembering that public health insurance accounts have been in deficit for many years, compromising the sustainability of the system.

2.6 Appendix

2.6.1 ESPS questions associated with unmet needs

1. Over the past 12 months, have you had to forego dental care for financial reasons?
2. Over the past 12 months, have you had to give up glasses, lenses, frames or contact lenses for financial reasons?
3. Over the past 12 months, have you had to forego a medical consultation for financial reasons?
4. Over the past 12 months, have you had to forego other treatments or examinations for financial reasons?
5. Over the past 12 months, have you had to forego care or examinations, including dental or optical ones, because it took too long to get an appointment?
6. Over the last 12 months, have you had to forego care or examinations, including dental or optical ones, because the practice was too far away or because you had travel problems to get there?

2.6.2 Instrumental variables

Knowing that an instrumental variable is a variable that theoretically has a significant effect on the probability of self-reporting unmet needs and does not have a significant effect on the health expenditure, we test the ‘validity’ of our instruments by introducing instruments as explanatory variables for expenditure in a standard regression model. The table below gives the results of the significance test of the parameters associated with these variables. The results show that the two variables considered (the poverty rate in the department and past financial problems) do not explain the amount of spending and therefore appear to be valid instruments. This test was completed by a model identification test [Table 2.6](#) which confirms this result.

Table 2.5: Significance of the instrumental variables in the different equations

	Unmet needs	Healthcare expenditure			
		All	All	with unmet needs	without unmet needs
Past financial problems	0.201*** (0.030)	0.044 (0.063)	0.067 (0.064)	0.148 (0.105)	0.048 (0.082)
Department poverty rate	0.012*** (0.004)	0.023 (0.018)	0.025 (0.018)	0.013 (0.013)	0.036 (0.023)
Unmet needs			-0.097 (0.063)		
Lagrange Multiplier (LM) test (χ^2)	52.53	2.80	3.31	2.18	3.11
Probability limit	0.000	0.247	0.191	0.336	0.211

Source: Enquête santé et protection sociale (ESPS) matched with Échantillon Généraliste de Bénéficiaires (EGB), 2012.

Note: A probit model was estimated for unmet needs. For the expenditure, the relationship was estimated by maximum likelihood. The estimated parameters associated with the instrumental variables are shown in the table; those associated with the other variables have not been reported. The number in parentheses is the standard error of the parameter (***) significance at 1%).

Table 2.6: Tests for model identification

Test	Null hypothesis	Statistic	Critical value of 5%
Anderson canonical correlation	Under-identification	56.9 (χ^2_2)	5.99
Cragg-Donald	Weak identification	19.385	Stock-Yogo 13.91
Sargan	Over-identification	3.461 (χ^2_1)	3.84
Unmet needs endogeneity		5.709 (χ^2_1)	3.84

Note: To perform these tests, the variable unmet needs is estimated from a linear probability model.

2.6.3 Switching model and conditional expectations

The selection equation is estimated with a probit model and the two equations associated with the two regimes for the logarithm of the health expenditure are assumed to be linear. The selection model is specified as follows:

$$R_i^* = Z_i \alpha + \eta_i = X_i \alpha_x + \mathcal{I}_i \alpha_{\mathcal{I}} + \eta_i ;$$

$$R_i = \begin{cases} 1 & \text{if } R_i^* > 0, \\ 0 & \text{else.} \end{cases}$$

Individuals report unmet needs ($R_i = 1$) when R_i^* , the associated latent variable, is positive. Z_i is a vector of explanatory variables and α is the vector of associated parameters.

The two equations associated with the switching regime are defined by:

$$Y_{1i} = X_i \beta_1 + \epsilon_{1i},$$

$$Y_{0i} = X_i \beta_0 + \epsilon_{0i},$$

Y_{1i} and Y_{0i} represent the logarithm of the health expenditure for individuals with and without unmet health needs respectively, β_1 and β_0 are for each subgroup the parameter vectors associated with the vector X_i . The two equations for the two subgroups are assumed to be independent. The error term η_i is correlated with the health expenditure error terms, ϵ_{1i} and ϵ_{0i} .

The error expectation conditional on subgroups selection is non-zero and is expressed as follows:

$$\mathbb{E}[\epsilon_{1i}|R_i = 1] = \sigma_{1\eta} \frac{\phi(Z_i\alpha)}{\Phi(Z_i\alpha)} = \sigma_{1\eta}\lambda_{1i},$$

$$\mathbb{E}[\epsilon_{0i}|R_i = 0] = -\sigma_{0\eta} \frac{\phi(Z_i\alpha)}{1 - \Phi(Z_i\alpha)} = \sigma_{0\eta}\lambda_{0i},$$

$\sigma_{1\eta}$ and $\sigma_{0\eta}$ are respectively the covariance between η_i and ϵ_{1i} , and ϵ_{0i} . There is no covariance between ϵ_{1i} and ϵ_{0i} . $\lambda_{1i} = \frac{\phi(Z_i\alpha)}{\Phi(Z_i\alpha)}$ and $\lambda_{0i} = -\frac{\phi(Z_i\alpha)}{1-\Phi(Z_i\alpha)}$ are the inverses of the Mills ratios which allow us to correct for the endogeneity bias and thus to compensate for the self-selection bias between subgroups. If the estimated covariance $\hat{\sigma}_{1\eta}$ and $\hat{\sigma}_{0\eta}$ are statistically significant, unmet needs and health expenditure are correlated, which makes it possible to reject the hypothesis of the absence of bias linked to the endogeneity of unmet needs. When the correction $\sigma_{j\eta}\lambda_{ji}$, ($j = 0, 1$) is positive, the unobserved variables in the selection model are positively associated with health expenditure and inversely when they are negative. ϕ and Φ are the probability density function and the distribution function of the reduced centered Normal law.

The full information maximum likelihood method provides efficient estimators for the switching model. Given different assumptions on the error terms, the log likelihood is given by:

$$\begin{aligned} \ln L = & \sum_{i=1}^N R_i \left[\ln \phi \left(\frac{Y_{1i} - X_i \beta_1}{\sigma_1} \right) - \ln \sigma_1 + \ln \Phi(\theta_{1i}) \right] \\ & + (1 - R_i) \left[\ln \phi \left(\frac{Y_{0i} - X_i \beta_0}{\sigma_0} \right) - \ln \sigma_0 + \ln (1 - \Phi(\theta_{0i})) \right], \end{aligned}$$

with $\theta_{ji} = \left[Z_i \alpha + \frac{\sigma_{j\eta}}{\sigma_j} (Y_{ji} - X_i \beta_j) \right]$, $j = 0, 1$; σ_1 and σ_0 are respectively the standard deviation of ϵ_{1i} and ϵ_{0i} .

The switching model (see, for example, DiFalco (Di Falco, 2011)) allows us to calculate the conditional expenditure expectations for people who have declared unmet needs (2.5) and those who have not declared any (2.6). However, it is also possible to calculate the counterfactuals, i.e. the conditional expectation of expenditure for people who had given up care if they had not finally given up (2.7) and conversely, the conditional expectation of expenditure for people who had not given up care if they had finally given up (2.8).

$$\mathbb{E}[Y_{1i} | R_i = 1] = X_i \beta_1 + \sigma_{1\eta} \lambda_{1i} \quad (2.5)$$

$$\mathbb{E}[Y_{0i} | R_i = 0] = X_i \beta_0 + \sigma_{0\eta} \lambda_{0i} \quad (2.6)$$

$$\mathbb{E}[Y_{0i} | R_i = 1] = X_i \beta_0 + \sigma_{0\eta} \lambda_{1i} \quad (2.7)$$

$$\mathbb{E}[Y_{1i} | R_i = 0] = X_i \beta_1 + \sigma_{1\eta} \lambda_{0i} \quad (2.8)$$

2.6.4 Alternative modeling in the context of robustness tests

Propensity score matching method

To further the robustness analysis, the average treatment effect among individuals reporting unmet needs (ATT) is estimated. Let R be the binary treatment of inter-

est ($R = 1$ for those with unmet need and $R = 0$ otherwise) and Y be the healthcare expenditure. The ATT is given by the difference: $\mathbb{E}[Y_1|R = 1] - \mathbb{E}[Y_0|R = 1]$. To account for potential confounding factors when assessing the effect of unmet needs on expenditure, a propensity score matching analysis that estimates ATT (for details see Imbens (Imbens, 2004)) is conducted. Propensity scores are calculated using a probit regression model including variables in Z defined for the regime-switching model. Propensity score matching is performed using the nearest neighbor method and a standard caliper¹⁵ of 0.2. Features with a standardized mean difference of less than 10% are considered well balanced. Finally, a matched linear regression is fitted to estimate the ATT. This method is based on the assumption of conditional independence on observable variables (CIA). To test the validity of this assumption the sensitivity analysis proposed by Ichino(Ichino, 2008) is performed. This method assumes the conditional independence assumption is not verified but it would be if an additional variable was observed.

IPTW method

An analysis by weighting individuals with the inverse of their treatment probability (IPTW) is then conducted. This method has three interests: 1) to allow estimation of both the ATT and the average treatment effect among the untreated (ATU) defined by $\mathbb{E}[Y_1|R = 0] - \mathbb{E}[Y_0|R = 0]$, 2) to take into account all the individuals in the database and 3) not requiring an instrumental variable¹⁶. For this purpose, the IPTW method reduces confounding by adjusting the contribution of an individual i by a weight W_i estimated from the value of R_i observed and p_i , the propensity score being estimated using a probit model. The weight W_i is defined differently for

¹⁵For this level of caliper, the matching rate is 91.4%. Results for different caliper values are available from the authors.

¹⁶This last element is also true for the propensity score matching method.

each effect¹⁷. Weight stabilization can help to reduce the variance of the estimated effect. Based on W_i , a weighted linear regression is fitted for healthcare expenditure, with the unmet needs variable as an explanatory variable.

Lewbel's method

The analysis proposed by Lewbel (Lewbel, 2012) can be compared to the instrumental variable model with two equations presented earlier, one for the selection equation and one for the expenditure. The fundamental difference between the two analyses is the nature of instrumental variables. The model of Lewbel (Lewbel, 2012) is based on the idea that no instrument is observed (either because of lack of data or because the instrumental variables chosen turn out not to be “good” instruments) but that instruments are constructed from the heteroskedasticity observed in the model defined by the following two-equation system:

$$\begin{cases} R_i = X_i \alpha + \epsilon_{2i}, \\ Y_i = X_i \beta + R_i \gamma + \epsilon_{1i}, \end{cases}$$

with α, β the vectors of parameters to be estimated associated with the vector of explanatory variables X_i for each equation and γ the parameter associated with R_i . Y_i and R_i are respectively health expenditure and unmet needs, both considered as continuous and endogenous. The instrument is constructed by exploiting the information contained in the heteroscedasticity of ϵ_2 . The estimation of the vector $\hat{\alpha}$ using an ordinary least squares regression allows to calculate the residuals $\hat{\epsilon}_{2i} = R_i - X_i \hat{\alpha}$. The instrument that identifies the parameter γ is constructed from the variable $(V_i - \bar{V}) \hat{\epsilon}_{2i}$ where V_i is a vector of all exogenous variables or only a subset of them and $\bar{V}$ is the mean of this vector. This method does not require any

¹⁷For example, for individual i , the ATT weight is defined as $W_i = R_i + (1 - R_i) \times \frac{p_i}{(1-p_i)}$, see Morgan (Morgan, 2008) for more details.

instrumental variable but the estimator relies on two assumptions: V_i is correlated with the heteroscedasticity of the errors in the R_i equation ($\text{Cov}(V_i, \epsilon_{2i}^2) \neq 0$), but is not correlated with the product of the error terms of the two equations ($\text{Cov}(V_i, \epsilon_{2i}\epsilon_{1i}) = 0$).

Tables

Table 2.7: Descriptive statistics

Unmet needs		No	(%)	Yes	(%)	All	(%)
Total		793	(72.4)	303	(27.6)	1096	
Gender	Female	435	(54.9)	189	(62.4)	624	(56.9)
	Male	358	(45.1)	114	(37.6)	472	(43.1)
Age	65-69	240	(30.3)	128	(42.2)	368	(33.6)
	70-74	170	(21.4)	58	(19.1)	228	(20.8)
	75-79	163	(20.6)	60	(19.8)	223	(20.3)
	80-84	121	(15.3)	32	(10.6)	153	(14.0)
	85+	99	(12.5)	25	(8.3)	124	(11.3)
Living with a partner	Yes	480	(60.5)	161	(53.1)	641	(58.5)
Experience of seclusion	Yes	98	(12.4)	66	(21.8)	164	(15.0)
Smoking status	Smoking cessation	205	(25.9)	80	(26.4)	285	(26.0)
	Do not smoke	508	(64.1)	183	(60.4)	691	(63.0)
	Less than 10 cigarettes a day	64	(8.1)	26	(8.6)	90	(8.2)
	More than 10 cigarettes a day	16	(2.0)	14	(4.6)	30	(2.7)
Education	Primary	407	(51.3)	153	(50.5)	560	(51.1)
	Secondary	302	(38.1)	112	(37.0)	414	(37.8)
	Higher	84	(10.6)	38	(12.5)	122	(11.1)
Past financial problems	Yes	157	(19.8)	135	(44.6)	292	(26.6)
CMU	Yes	11	(1.4)	6	(2.0)	17	(1.6)
Supplementary insurance	Yes	759	(95.7)	268	(88.4)	1027	(93.7)
Socio-professional category	Manager	199	(25.1)	71	(23.4)	270	(24.6)
	Inactive	34	(4.3)	17	(5.6)	51	(4.7)
	Self-employed	136	(17.2)	47	(15.5)	183	(16.7)
	Worker or employee	424	(53.5)	168	(55.4)	592	(54.0)
Living area	Big City	370	(46.7)	163	(53.8)	533	(48.6)
	Suburbs	218	(27.5)	62	(20.5)	280	(25.5)
	Other	205	(25.9)	78	(25.7)	283	(25.8)
Daily alcohol consumption	Never	268	(33.8)	126	(41.6)	394	(35.9)
	Less than one glass	279	(35.2)	107	(35.3)	386	(35.2)
	One glass or more	246	(31.0)	70	(23.1)	316	(28.8)
Concern about the future	Yes	259	(32.7)	123	(40.6)	382	(34.9)
Risky attitude	Yes	114	(14.4)	48	(15.8)	162	(14.8)
Social life	Yes	685	(86.4)	251	(82.8)	936	(85.4)
High income	Yes	357	(45.0)	105	(34.7)	462	(42.2)
Frailty	Frail	93	(11.7)	58	(19.1)	151	(13.8)
	Prefrail	266	(33.5)	108	(35.6)	374	(34.1)

continued on next page

Table 2.7: Descriptive statistics (continued)

Unmet needs		No	(%)	Yes	(%)	All	(%)
	Robust	434	(54.7)	137	(45.2)	571	(52.1)
ADL	Yes	119	(15.0)	61	(20.1)	180	(16.4)
Number of pathologies	None	269	(33.9)	74	(24.4)	343	(31.3)
	One	256	(32.3)	87	(28.7)	343	(31.3)
	More than one	268	(33.8)	142	(46.9)	410	(37.4)
Pathologies	Asthma	95	(12.0)	51	(16.8)	146	(13.3)
	Bronchitis	106	(13.4)	48	(15.8)	154	(14.1)
	Infarction	49	(6.2)	11	(3.6)	60	(5.5)
	Coronary problems	72	(9.1)	27	(8.9)	99	(9.0)
	Hypertension	244	(30.8)	122	(40.3)	366	(33.4)
	Cerebral congestion	46	(5.8)	10	(3.3)	56	(5.1)
	Arthritis	315	(39.7)	123	(40.6)	438	(40.0)
	Back pain	235	(29.6)	106	(35.0)	341	(31.1)
	Neck pain	181	(22.8)	81	(26.7)	262	(23.9)
	Diabetes	148	(18.7)	82	(27.1)	230	(21.0)
	Allergies	121	(15.3)	61	(20.1)	182	(16.6)
	Cirrhosis	36	(4.5)	7	(2.3)	43	(3.9)
	Urinary problems	112	(14.1)	51	(16.8)	163	(14.9)
	Depression	66	(8.3)	41	(13.5)	107	(9.8)
Healthcare expenditure Mean (Std. dev.)		2560.7	(2754.5)	2747.1	(3793.6)	2612.2	(3076.4)

Source: Enquête santé et protection sociale (ESPS) matched with Échantillon Généraliste de Bénéficiaires (EGB), 2012.

Table 2.8: CIA hypothesis sensitivity tests

Variable	ATT	SE	Γ	Λ
Gender	-0.086	0.118	1.031	0.865
Supplementary insurance	-0.088	0.121	1.212	0.501
CMU	-0.094	0.119	8.278	1.388
Living with a partner	-0.098	0.117	0.814	0.864
Risky attitude	-0.091	0.119	1.035	1.089
Experience of seclusion	-0.104	0.117	1.343	1.419
Social life	-0.096	0.120	0.987	0.848
ADL	-0.112	0.118	1.922	1.213
High income	-0.098	0.118	0.888	0.768
Concern about the future	-0.100	0.118	1.055	1.218
Past financial problems	-0.109	0.120	1.187	2.057

Note : The method consists of simulating a confounding variable CV , i.e. a binary variable related to unmet needs and expenditure (unobserved variable). This is equivalent to assuming that the CIA hypothesis is verified by CV and is not verified otherwise. The probabilities were assigned based on the distributions of the explanatory variables. The ATTs are obtained by simulations. Λ measures the effect of the variable CV on the probability of reporting unmet needs and Γ measures the impact of CV on expenditure.

Table 2.9: Estimation by alternative methods

Variable	Class	Lewbel		IV	
		Estimate	SE	Estimate	SE
Gender (Ref. Female)	Male	0.02	0.07	0.09	0.07
Age (Ref. 65-69)	70-74	0.13	0.08	0.15*	0.08
	75-79	0.16*	0.09	0.16*	0.08
	80-84	0.17	0.11	0.25**	0.09
	85+	0.03	0.13	0.08	0.11
Socio-professional category of the last job (Ref. Managers)	Inactive	-0.16	0.15	-0.16	0.15
	Self-employed	-0.01	0.09	-0.03	0.09
	Worker or employee	-0.04	0.10	-0.01	0.08
CMU	Yes	0.57**	0.25	0.53**	0.24
Supplementary insurance	Yes	0.44***	0.14	0.44***	0.13
Living with a partner	Yes	-0.10	0.06	-0.11*	0.06
Daily alcohol consumption (Ref. Never)	Less than one glass	-0.17**	0.07	-0.21***	0.07
	One glass or more	-0.25**	0.08	-0.23***	0.07
Smoking status (Ref. Smoking cessation)	Do not smoke	-0.18**	0.07	-0.13*	0.07
	Less than 10 cigarettes a day	-0.27**	0.11	-0.10	0.10
	More than 10 cigarettes a day	0.04	0.19	-0.05	0.17
Risky attitude	Yes	0.06	0.08	-0.01	0.08
Education (Ref. Primary)	Secondary	0.00	0.07	0.01	0.06
	Higher	0.15	0.11	0.11	0.11
Experience of seclusion	Yes	0.00	0.08	-0.04	0.08
Social life	Yes	0.00	0.08	-0.00	0.08
Living area (Ref. Big city)	Suburbs	0.14**	0.07	0.13*	0.07
	Other	0.08	0.07	0.07	0.07
ADL	Yes	0.18**	0.09	0.18**	0.09
Number of pathologies (Ref. None)	One	0.29***	0.07	0.30***	0.07
	More than one	0.52***	0.07	0.52***	0.07
Frailty (Ref. Robust)	Prefrail	0.35***	0.06	0.34***	0.06
	Frail	0.70***	0.11	0.67***	0.10
High income	Yes	0.02	0.07	0.06	0.07
Concern about the future	Yes	0.06	0.06	0.02	0.06
Past financial problems	Yes	0.06	0.10		
County poverty rate		0.02	0.02		
Unmet needs		-0.01	0.38	0.31	0.19
ρ				-0.28**	0.13

Source: Enquête santé et protection sociale (ESPS) matched with Échantillon Généraliste de Bénéficiaires (EGB), 2012.

Note: For each estimated relationship, the first column is the estimated coefficient (significance level: * 10%, ** 5%, *** 1%) and the second column the estimated standard errors. The IV model is estimated by maximum likelihood.

Table 2.10: Sample characteristics after matching

Unmet needs		No	(%)	Yes	(%)	p-value
Total		256	(50)	256	(50)	
Gender	Female	150	(59)	155	(61)	0.653
Age	65-69	98	(38)	105	(41)	0.888
	70-74	54	(21)	54	(21)	
	75-79	54	(21)	49	(19)	
	80-84	33	(13)	28	(11)	
	85+	17	(6.6)	20	(7.8)	
Living with a partner	Yes	140	(55)	145	(57)	0.656
Experience of seclusion	Yes	49	(19)	49	(19)	1.000
Smoking status	Smoking cessation	69	(27)	66	(26)	0.782
	Do not smoke	156	(61)	157	(61)	
	Less than 10 cigarettes a day	19	(7)	24	(9)	
	More than 10 cigarettes a day	12	(5)	9	(4)	
Education	Primary	129	(50)	130	(51)	0.991
	Secondary	92	(36)	92	(36)	
	Higher	35	(14)	34	(13)	
Past financial problems	Yes	99	(39)	103	(40)	0.718
CMU	Yes	8	(3)	5	(2)	0.399
Supplementary insurance	Yes	230	(90)	229	(89)	0.885
Socio-professional category of the last job	Manager	74	(29)	62	(24)	0.694
	Inactive	11	(4)	12	(5)	
	Self-employed	37	(14)	39	(15)	
	Worker or employee	134	(52)	143	(56)	
Living area	Big city	136	(53)	135	(53)	0.897
	Suburbs	53	(21)	57	(22)	
	Other	67	(26)	64	(25)	
Daily alcohol consumption	Never	103	(40)	105	(41)	0.891
	Less than one glass	95	(37)	90	(35)	
	One glass or more	58	(23)	61	(24)	
Concern about the future	Yes	103	(40)	100	(39)	0.786
Risky attitude	Yes	43	(17)	41	(16)	0.811
Social life	Yes	213	(83)	216	(84)	0.719
High income	Yes	93	(36)	94	(37)	0.927
Frailty	Frail	32	(12)	38	(15)	0.734
	Prefrail	96	(38)	95	(37)	
	Robust	128	(50)	123	(48)	
ADL	Yes	38	(15)	46	(18)	0.340
Number of pathologies	None	80	(31)	64	(25)	0.210
	One	67	(26)	81	(32)	

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Unmet needs	No	(%)	Yes	(%)	p-value
More than one	109	(43)	111	(43)	

Source: Enquête santé et protection sociale (ESPS) matched with Échantillon Généraliste de Bénéficiaires (EGB), 2012.

Chapter 3

Analysis of Depression's Impact on Health Status During COVID-19 Pandemic: Diabetic vs. Non-Diabetic Population

3.1 Abstract

This study aims to explore the comparative influence of depression on health outcomes during the COVID-19 pandemic, focusing on individuals aged 60 and above with and without diabetes. By examining the differential impacts of depression on these groups, the study seeks to uncover insights that could guide targeted interventions and support mechanisms to mitigate health deterioration during such crises. Using data from the Survey of Health, Ageing, and Retirement in Europe (SHARE) spanning 2015 to 2020, this research investigates the mediating effects of depression, assessed based on European depression scale, on health deterioration (self-rated item) amid the pandemic. A G-computation marginal structural

model, based on a hypothetical directly acyclic graph, was employed analyze the direct effects of diabetes and the mediated effects through depression in a sample of treated diabetic individuals compared to their non-diabetic counterparts. The study analyzed 3,177 participants, categorizing them into diabetic (n=689) and non-diabetic (n=2488) groups. Descriptive analysis indicated a strong association between health status and depression, with a more pronounced correlation in diabetic individuals. Mediation analysis revealed significant indirect effects of depression on health deterioration (ATE=1.06 [CI 1.01-1.1]), while the direct effects of diabetes were not statistically significant. The findings demonstrate a significant interconnection between diabetes, depression, and health deterioration during the COVID-19 pandemic. These results emphasize the importance of integrated management strategies that address both mental and physical health to support individuals with diabetes during global health crises.

3.2 Introduction

Diabetes represents a burgeoning global health crisis, with its prevalence steadily rising and projected to affect an estimated 700 million individuals by 2045 (Saeedi, 2019). This escalating burden exerts substantial pressure on healthcare systems worldwide, necessitating a comprehensive understanding of its impact on both public health and healthcare infrastructure.

Depression is one of the most frequent comorbidity among patients with diabetes, with a prevalence of depression reaching two to three times higher than general population (Badescu, 2016). These two conditions are inextricably linked, with depression contributing to and being exacerbated by diabetes, forming a complex interplay. Katon's seminal work highlights this connection, underscoring the association between depression and several Framingham risk factors, such as smoking,

obesity, and sedentary lifestyles (Katon, 2008).

Older population presents a high prevalence of diabetes and is associated with frailty which is an age-associated condition that can lead to health condition worsening. The worldwide prevalence was estimated to be 22-26% among those aged 70 or older (Jiang, 2023). The relationship between diabetes and frailty is not clear though bidirectional relationship has been suggested as low grade inflammation and oxidative stress were associated with both condition (Abd.Ghafar, 2022). Moreover, prehypertension and hypertension have been shown to be associated with diabetes (Kim, 2015). Of note, patients with both hypertension and diabetes are more at risk of cardiovascular disease complications and require a more intensive care management (Marx, 2023).

Within high-income countries, the elderly population faces unique challenges related to diabetes and an increased risk of depression (Khan, 2020; Zenebe, 2021). This demographic shift towards an aging society intensifies the importance of investigating how these conditions intersect among older adults. Furthermore, it is associated with poorer adherence to treatment, jeopardizing diabetes management (Markowitz, 2011), and is generally underdiagnosed (Herrera, 2021). Past research, as exemplified by Bashkin, has delved into the relationship between diabetes and depression in older adults. These studies emphasize the importance of considering multimorbidity in aged patients, shedding light on the complex health landscape this population navigates (Bashkin, 2018).

The emergence of the coronavirus disease 2019 (COVID-19) pandemic introduced an unparalleled global crisis, impacting healthcare systems, social interactions, and vulnerable populations worldwide (Lekamwasam, 2020). Marginalized populations, notably older adults, have borne a disproportionate burden of the pandemic's consequences, facing increased risks related to disease complications and infections (Lekamwasam, 2020). Moreover, the pandemic's multifaceted impact on the general

population and particularly on older adults has disrupted their social lives, access to services, sleep patterns, and physical activity levels (Gualano, 2020; Lebrasseur, 2021). Increased stress, anxiety, and depression and disrupted sleep has been reported (Al-Moteri, 2022).

Amidst the pandemic, individuals with diabetes have experienced heightened anxiety and depression, exacerbated by the challenging circumstances, as outlined by Myers (Myers, 2022). Reduced physical activity during COVID-19 lockdown has been linked to worsened blood glucose control and diabetes management deteriorated after emergencies (Al-Moteri, 2022; Tanji, 2021). People with diabetes were more likely to report medical visit due to depressive symptoms (Al-Sofiani, 2021). Also, sarcopenia is another condition that has been related to diabetes and depression (Kirwan, 2020). For instance, low physical or reduced activity have been shown to lead to loss of muscle mass and physical function (Kirwan, 2020), that may trigger relating comorbidities such as depression. Feelings of isolation among individuals with diabetes during the pandemic have also been reported (Holloway, 2021). There is evidence that among patients with diabetes, the pandemic had a negative impact on mental health (Holloway, 2021; Moradian, 2021). People infected by COVID-19 were more likely to be older, and have noncommunicable diseases, especially diabetes (He, 2022). Polycomorbidity, long-term drug use, nutrition and poor social habits are known to be related to a higher likelihood of being infected among the elderly population, which may be aggravated by pandemic restrictions (Lekamwasam, 2020).

The unprecedented challenges posed by the global pandemic have had a profound impact on public health, necessitating a deeper understanding of its effects on individuals with pre-existing health conditions. Specifically, the objective of this study is to elucidate the comparative influence of depression on the exacerbation of health outcomes amidst the pandemic, focusing on individuals with diabetes versus those

without. By investigating the differential impact of depression on these distinct populations, the study aims to uncover nuanced insights that could inform targeted interventions and support mechanisms to mitigate health deterioration during such crises.

3.3 Materials and Methods

3.3.1 Data source

The study utilized data from the Survey of Health, Ageing, and Retirement in Europe (SHARE), which is a multidisciplinary and cross-national panel database of micro data on health, socio-economic status and social and family networks collected from more than 85,000 individuals in 28 European countries. In this study, we utilized the data from all countries in panels in 2015 (First wave), and 2019/2020 (Final wave), and also a dedicated COVID-19 survey conducted in 2019/2020.

3.3.2 Target population

The target population for this study was defined as individuals aged 60 years and older who declared having diabetes in 2015 wave and were actively taking medication for their condition at that time. In addition, we restricted to those with hypertension since this is reported as a risk factor for cardiovascular event and require particular care management (Marx, 2023). This population was followed longitudinally from 2015 to the timing of the COVID-19 survey. To focus on individual with incident depressive episode, only individuals without depression in 2015 were included in the analysis. To compare diabetic population, we also identified a non-diabetic group to compare the effect of depression on health status during COVID-19 pandemic. Non-diabetic individuals were defined as individuals with

no reported chronic diseases and aged 60 years or more in 2015. Identically as for diabetic patients, only individual without depression in 2015 were included.

3.3.3 Depression

Depressive symptoms were assessed using the European Depression (EURO-D) scale, a validated instrument consisting of 12 items that evaluate depressive symptoms, pessimism, and a death wish (Castro-Costa, 2007). Scores on the EURO-D scale ranged from 0 to 12, with a cut-off score of 4 indicating the presence of depression (Castro-Costa, 2007). Depression patterns were categorized based on the presence or absence of depression at 2019/2020 wave. In this study, we considered depression as a mediator of the impact of diabetes on health status during COVID-19 pandemic.

3.3.4 Health status change during COVID-19 Pandemic

Health status change during the COVID-19 pandemic compared to pre-pandemic was assessed based on the following question: "If you compare your health with that before the outbreak of COVID-19, would you say your health has improved, worsened, or stayed about the same?". Individuals who reported worsened status were classified as those with health worsening, and other individuals were considering as those without health worsening.

3.3.5 Risk factors for diabetes and depression

The analysis included a comprehensive list of risk factors relating to diabetes and depression based on the available literature, included demographic, behavior-related and clinical-related variables identified at the wave in 2015 (Hare, 2014; Mozaffarian, 2009; Zenebe, 2021). As for socio-demographic or behavior-related risk factors,

this included gender and years of education, marital status (Living alone, living with a partner), drinking status (Not at all, less than once a month, once or twice a month, once or twice a week, more than three times a week), smoking status (Never smoked, currently smoking, has quit smoking), and physical activity (Activity requiring a moderate level of energy categorized as: more than once a week, once a week, one to three times a month, less often). As for clinical characteristics, we included the history of cardiovascular disease, history of stroke, body mass index (BMI) and frailty status (Robust, pre-frail, frail). Frailty status was categorized based on Fried’s criteria, including exhaustion, slowness, weakness, low physical activity, and weight loss as described in Fried’s work (Fried, 2001).

3.3.6 Underlying model of the analysis

A directed acyclic graph (DAG) illustrated the causal structure of our model (Figure 3.1). It assume a causal relationship between diabetes and depression, depression and health status during COVID-19 pandemic, and depression and health status. Depression was considered as the mediator of diabetes although diabetes was considered to have a direct effect on health status. Risk factors identified in 2015 wave as described in the previous section were considered in the model to adjust for confounding among diabetes, depression and health status during COVID-19 pandemic as illustrated in Figure 3.1). To estimate the direct effect of diabetes on health status, and indirect effect mediated via depression, we chose to implement a 2-way decomposition as reported in Wang et al. (Wang, 2015). To do so, we implemented G-computation marginal structural model. Basically, this method consists of three steps. First, based on the empirical distribution of each variable, depression was modeled using a logistic regression with risk factors (Figure 3.1) as explanatory variables. Similarly, health status was modeled with depression and risk factors as explanatory variables. The second step consisted in creating 1 million

copies of the original sample to create marginally independent covariates. Based on this simulated covariates, an intervention variable for diabetes, that is marginally independent from simulated covariates, was simulated. Then, we simulated the mediator, i.e. depression, based on the simulated intervention variable (diabetes) and covariates using the model estimated in the previous step. Finally, we simulated the outcome, health status during COVID-19 pandemic, based on the simulated intervention variable, mediator and covariates for each counterfactual to estimate the different effects. In the final step, we regressed simulated the outcome on the simulated intervention variable to estimate the marginal effects. The 95% confidence intervals (CI) were estimated using bootstrapping (Wang, 2015). To assess the robustness of the method, we also used a parametric method as described by Lange et al., which is the ratio-of-mediator-probability weighting method (RMPW) (Lange, 2012). Using these weights allows to remove the confounding between the exposure and the mediator. In this study, all statistical analyses were carried out using the R statistical software (version 4.1.3, R Foundation for Statistical Computing, Vienna, Austria).

3.4 Results

3.4.1 Cohorts

This study analyzed 3177 individuals, categorizing them into diabetic (n=689) and non-diabetic (n=2488) groups. The diabetic cohort predominantly consisted of males (54% vs. 50%), was older (mean age 71 vs. 68 years), and had less education (average years 11.1 vs. 12.0). They also exhibited poorer smoking habits and reduced physical activity. Statistically significant differences were noted across all examined clinical parameters. Diabetic individuals demonstrated a higher association with deteriorating health during the pandemic (11% vs. 5.6%), increased frailty

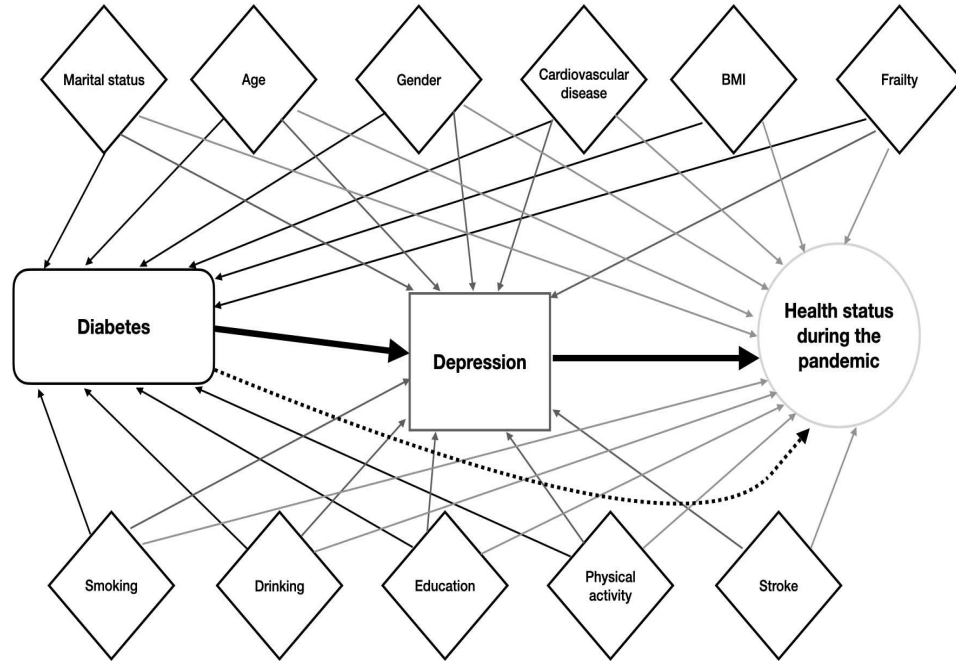


Figure 3.1: Directed acyclic graph of relationships between diabetes, depression, and health status during COVID-19 pandemic.

Solid arrows and dashed arrows depict direct and indirect effects, respectively.

Diamond boxes indicate covariates used in the G-Computation model. Abbreviations: BMI, Body Mass Index.

(7.3% vs. 0.5%), higher BMI, and elevated rates of cardiovascular diseases (18% vs. 5.3%), stroke history (5.7% vs. 0.8%), and depression (23% vs. 12%).

3.4.2 Differences in individuals with depression

In our comparative analysis of characteristics by depression status across diabetic and non-diabetic populations, we identified significant associations. Depression was strongly correlated with being female and having fewer years of education in both cohorts ([Table 3.2](#)). Additionally, worse frailty status was observed, along with higher incidences of health deterioration during the pandemic (Diabetic: 19% vs. 8.3%; Non-diabetic: 9.2% vs. 2.2%) and cardiovascular disease (Diabetic: 25% vs. 15%; Non-diabetic: 7.9% vs. 4.9%). Notably, among diabetics, a better drinking status correlated with depression.

Table 3.1: Characteristics of diabetic and non-diabetic individuals

Characteristics	Overall	Diabetic	Non-diabetic	p-value*
Sample size, N	3,177	689	2,488	
Gender				0.037
Male	51% (1,608)	54% (373)	50% (1,235)	
Female	49% (1,569)	46% (316)	50% (1,253)	
Marital status				0.18
Living alone	26% (836)	28% (195)	26% (641)	
Living with a partner	74% (2,341)	72% (494)	74% (1,847)	
Drinking status				0.73
Not at all	77% (2,462)	79% (545)	77% (1,917)	
Less than once a month	10% (322)	10% (69)	10% (253)	
Once or twice a month	6% (179)	5% (34)	6% (145)	
Once or twice a week	3% (98)	3% (20)	3% (78)	
More than three times a week	4% (116)	3% (21)	4% (95)	
Smoking status				<0.001
Never smoked	57% (1,805)	55% (380)	57% (1,425)	
Currently smoking	13% (422)	10% (66)	14% (356)	
Has quit smoking	30% (950)	35% (243)	28% (707)	
Physical activity				<0.001
More than once a week	80% (2,542)	70% (479)	83% (2,063)	
Once a week	12% (374)	14% (94)	11% (280)	
One to three times a month	4% (136)	7% (45)	4% (91)	
Less often	4% (125)	10% (71)	2% (54)	
Health worsening during the pandemic	6.7% (213)	11% (74)	5.6% (139)	<0.001
Frailty status				<0.001
Robust	69% (2,202)	47% (324)	75% (1,878)	
Pre-frail	29% (912)	46% (315)	24% (597)	
Frail	2% (63)	7% (50)	1% (13)	
BMI				<0.001
12.5-18.5	1% (34)	0.4% (3)	1% (31)	
18.5-25.0	39% (1,244)	11% (74)	47% (1,170)	
25-30	41% (1,297)	42% (292)	40% (1,005)	
More than 30	19% (602)	46% (320)	11% (282)	
Cardiovascular disease	8.0% (253)	18% (121)	5.3% (132)	<0.001
History of stroke	1.8% (58)	5.7% (39)	0.8% (19)	<0.001
Depression after baseline	15% (464)	23% (160)	12% (304)	<0.001
Years of education - Mean (SD)	11.8 (4.5)	11.1 (4.1)	12.0 (4.5)	<0.001
Age - Mean (SD)	69 (7)	71 (7)	68 (7)	<0.001

*Pearson's Chi-squared test; Wilcoxon rank sum test; ** Numbers indicate % and size (N)

Table 3.2: Characteristics by depression status among individuals

Characteristics	Diabetic patients			Non-diabetic patients		
	No depression	Depression	p-value	No depression	Depression	p-value
Sample size, N	529	160		2,184	304	
Gender			<0.001			<0.001
Male	58% (305)	42% (68)		51% (1,122)	37% (113)	
Female	42% (224)	57% (92)		49% (1,062)	63% (191)	
Marital status			0.39			0.35
Living alone	29% (154)	26% (41)		25% (556)	28% (85)	
Living with a partner	71% (375)	74% (119)		75% (1,628)	72% (219)	
Drinking status			0.002			0.49
Not at all	76% (401)	90% (144)		77% (1,675)	80% (242)	
Less than once a month	12% (62)	4% (7)		10% (228)	8% (25)	
Once or twice a month	5% (28)	4% (6)		6% (125)	7% (20)	
Once or twice a week	3% (18)	1% (2)		3% (72)	2% (6)	
More than three times a week	4% (20)	1% (1)		4% (84)	4% (11)	
Smoking status			0.70			0.12
Never smoked	54% (288)	57% (92)		58% (1,261)	54% (164)	
Currently smoking	10% (50)	10% (16)		14% (301)	18% (55)	
Has quit smoking	36% (191)	32% (52)		28% (622)	28% (85)	
Physical activity			0.68			0.93
More than once a week	70% (372)	67% (107)		83% (1,814)	82% (249)	
Once a week	14% (73)	13% (21)		11% (245)	12% (35)	
One to three times a month	6% (33)	8% (12)		4% (78)	4% (13)	
Less often	10% (51)	12% (20)		2% (47)	2% (7)	
Health worsening during COVID	8% (44)	19% (30)	<0.001	5.1% (111)	9.2% (28)	0.003
Frailty status			0.006			<0.001
Robust	49% (260)	40% (64)		78% (1,694)	61% (184)	
Pre-frail	45% (239)	48% (76)		22% (480)	38% (117)	
Frail	6% (30)	12% (20)		1% (10)	1% (3)	
BMI			0.51			0.29
12.5-18.5	1% (3)	0% (0)		1% (28)	1% (3)	
18.5-25.0	11% (56)	11% (18)		47% (1,036)	44% (134)	
25-30	44% (231)	38% (61)		40% (882)	40% (123)	
More than 30	45% (239)	51% (81)		11% (238)	14% (44)	
Cardiovascular disease	15% (81)	25% (40)	0.005	4.9% (108)	7.9% (24)	0.032
History of stroke	5.5% (29)	6.2% (10)	0.71	0.7% (16)	1.0% (3)	0.50
Years of education - Mean (SD)	11.4 (4.1)	10.2 (3.9)	<0.001	12.1 (4.5)	11.3 (4.6)	<0.001
Age - Mean (SD)	71 (6)	72 (7)	0.22	68 (6)	69 (7)	0.070

* Pearson's Chi-squared test; Wilcoxon rank sum test; Fisher's exact test; ** Numbers indicate % and size (N)

3.4.3 Differences in individuals with health worsening during COVID-19 pandemic vs. those without

Our analysis further explored the health profiles of diabetic and non-diabetic individuals during the pandemic, stratified by their depression status (Table 3.3).

Health status demonstrated a significant positive correlation with depression across both groups, with diabetic individuals showing a stronger association compared to non-diabetics. Within the non-diabetic cohort, those experiencing worsening health

were significantly older, more likely to live alone, and had a poorer frailty status.

Table 3.3: Characteristics by health status during COVID-19 pandemic

Characteristics	Diabetic patients			Non-diabetic patients		
	No health worsening	Health worsening	p-value*	No health worsening	Health worsening	p-value*
Sample size, N	615	74		2,349	139	
Gender			0.79			0.22
Male	54% (334)	53% (39)		49% (1,159)	55% (76)	
Female	46% (281)	47% (35)		51% (1,190)	45% (63)	
Marital status			0.27			0.042
Living alone	28% (170)	34% (25)		25% (595)	33% (46)	
Living with a partner	72% (445)	66% (49)		75% (1,754)	67% (93)	
Drinking status			0.19			0.50
Not at all	78% (480)	88% (65)		77% (1,805)	81% (112)	
Less than once a month	11% (65)	5% (4)		10% (242)	8% (11)	
Once or twice a month	5% (32)	3% (2)		6% (136)	7% (9)	
Once or twice a week	3% (17)	4% (3)		3% (73)	4% (5)	
More than three times a week	3% (21)	0% (0)		4% (93)	1% (2)	
Smoking status			0.66			0.56
Never smoked	55% (337)	58% (43)		57% (1,349)	55% (76)	
Currently smoking	10% (61)	7% (5)		14% (338)	13% (18)	
Has quit smoking	35% (217)	35% (26)		28% (662)	32% (45)	
Physical activity			0.67			0.059
More than once a week	69% (425)	73% (54)		83% (1,954)	78% (109)	
Once a week	14% (87)	10% (7)		11% (265)	11% (15)	
One to three times a month	7% (41)	5% (4)		3% (80)	8% (11)	
Less often	10% (62)	12% (9)		2% (50)	3% (4)	
Frailty status			0.051			0.005
Robust	49% (299)	34% (25)		76% (1,788)	65% (90)	
Pre-frail	44% (272)	58% (43)		23% (550)	34% (47)	
Frail	7% (44)	8% (6)		0.5% (11)	1% (2)	
BMI			0.89			0.75
12.5-18.5	0.5% (3)	0% (0)		1% (30)	0.7% (1)	
18.5-25.0	11% (67)	10% (7)		47% (1,109)	44% (61)	
25-30	43% (262)	41% (30)		40% (947)	42% (58)	
More than 30	46% (283)	50% (37)		11% (263)	14% (19)	
Cardiovascular disease	17% (105)	22% (16)	0.33	5% (121)	8% (11)	0.16
History of stroke	5% (32)	10% (7)	0.18	0.7% (16)	2% (3)	0.086
Years of education - Mean (SD)	11.2 (4.1)	10.7 (4.0)	0.35	12.1 (4.5)	11.5 (4.8)	0.20
Age - Mean (SD)	71 (6)	73 (7)	0.060	68 (6)	71 (7)	<0.001

*Pearson's Chi-squared test; Wilcoxon rank sum test; Fisher's exact test; ** Numbers indicate % and size (N)

3.4.4 Mediation analysis

Our study utilized a mediation model to investigate the impact of diabetic status on health during the COVID-19 pandemic, with depression acting as a mediator (Table 3.4). Our analysis identified a significant total indirect effect of diabetic status on health through depression, demonstrating mediation. The odds ratios for this indirect effect were consistent across ATE, ATT, and ATU at 1.06. The direct effects were not significant, suggesting depression's pivotal role in affecting health outcomes for diabetics during the pandemic. A weighted approach confirmed these findings, with an indirect effect odds ratio of 1.05 and nonsignificant direct effects,

underscoring the robustness of our mediation analysis (Table 3.4).

Table 3.4: Effect Estimates from G-Computation Marginal Structural Model and RMPW

Analysis	Effect	Type of effect	Odds ratio [95% CI]
G-computation marginal structural model	Total effect	ATE	1.04 [1.02-1.11]
		ATT	1.06 [1.02-1.12]
		ATU	1.06 [1.01-1.11]
	Indirect effect	ATE	1.06 [1.01-1.10]
		ATT	1.06 [1.01-1.12]
		ATU	1.06 [1.01-1.11]
	Direct effect	ATE	1.01 [0.98-1.02]
		ATT	1.00 [0.98-1.02]
		ATU	1.01 [0.98-1.02]
RMPW	Indirect effect	ATE	1.05 [1.01-1.10]
	Direct effect	ATE	1.18 [0.83-1.69]

Abbreviations: ATE (Average Treatment Effect); ATT (Average Treatment effect on the Treated); ATU (Average Treatment effect on the Untreated); RMPW (Ratio-of-Mediator-Probability Weighting Method).

3.5 Discussion

The study elucidates the complex interplay between diabetic status, depression, and health outcomes amid the COVID-19 pandemic, highlighting depression's mediating role. Findings indicate that diabetic individuals, especially when depressed, are at heightened risk of deteriorating health during the pandemic. This underscores the need for holistic care strategies that address both the physical and mental health challenges faced by individuals with diabetes, particularly in the context of global health emergencies.

First, our study confirmed several risks associated with diabetes through descriptive analysis, identifying key determinants such as years of education, age, smoking status, physical activity, frailty, BMI, cardiovascular disease, and history of stroke (Mozaffarian, 2009). These findings emphasize the multifaceted nature of diabetes risk factors, underscoring the importance of comprehensive approaches in diabetes management and prevention strategies. Secondly, our study descriptively confirmed that depression significantly is associated with frailty and cardiovascular disease in

elderly diabetic patients but also non diabetic individuals. This interplay between physical and mental health not only exacerbates these conditions but also adversely impacts daily activities and overall mental well-being. This was consistent with previous literature highlighting a strong risk for those with history of cardiac illness and depression and frailty were reported to co-occur and depression was shown to be associated with frailty (Borges, 2020; Zenebe, 2021).

Finally, our main study findings indicate that depression mediated the effect of diabetes on health worsening during the COVID-19 pandemic, emphasizing critical areas of concern. Health worsening encompasses both mental and physical health changes. However, depression is associated with poorer diabetes management, as evidenced by higher Hemoglobin A1c (HbA1c) levels and reduced glucose monitoring (Al-Sofiani, 2021). This relationship suggests that depression exacerbates difficulties in diabetes care, potentially due to poor access to healthcare services for underlying reasons, such as fear of acquiring COVID-19, lack of telecommunication with healthcare providers, and challenges in medication management (Al-Sofiani, 2021; Splinter, 2021). These findings underscore the importance of addressing mental health alongside physical health in managing diabetes, particularly during global health crises like the COVID-19 pandemic. Moreover, patients with diabetes who do not manage their condition optimally face increased risks of adverse outcomes if infected with COVID-19, as highlighted by Sacks, emphasizing the importance of rigorous diabetes management during the pandemic to mitigate these risks (Sacks, 2020). Effective management includes regular monitoring of blood glucose levels and lifestyle modifications to ensure optimal control of diabetes and reduce vulnerability to severe COVID-19 complications (Kodani, 2022; Sacks, 2020).

Another factor that may contribute to the deterioration of health among diabetic patients during the pandemic is neuroticism, characterized by a predisposition towards experiencing negative emotions, anxiety, or depression. The exacerbation of

health conditions during this period may reflect declining mental health among individuals with high levels of neuroticism, highlighting the profound impact of the pandemic on those predisposed to mental health challenges (Ottenheim, 2022). Specifically, neuroticism has been shown to influence fear of hyperglycemia among diabetic patients, increasing their burden and reducing quality of life (Huang, 2021). We hypothesized that targeted interventions for diabetic patients experiencing depression may be beneficial in mitigating health deterioration during crises such as the COVID-19 pandemic. Cognitive Behavioral Therapy (CBT) emerges as an effective treatment, improving depressive symptoms, diabetic distress, and medical adherence, thereby enhancing HbA1c levels (Abbas, 2023; Dong, 2023; Noroozi, 2017). Furthermore, telemedicine, by facilitating better communication and providing emotional support could significantly reduce HbA1c levels and depressive symptoms (Zhai, 2014; Zhang, 2022). Ensuring equitable access to these interventions, with a focus on health literacy, is crucial for addressing healthcare disparities and optimizing both mental health and glycemic control (Dopelt, 2021).

The strength of this study relies on the assessment of causal link between depression and health status amidst the COVID-19 pandemic within a diabetic cohort, highlighted by our methodological rigor and the diversity of our multicountry sample. However, limitations include the inability to probe long-term health post-COVID-19, reliance on a singular self-reported health outcome measure, and missing data on glycemic control, comorbidity severity, and socio-demographic factors, which restricts a deeper analysis. Future studies should aim to include comprehensive data to better understand these dynamics. Additionally, the reliance on self-reported health information may introduce bias.

Our research identified a significant relationship between diabetes, depression, and health deterioration during the COVID-19 pandemic, highlighting the intertwined nature of these conditions. The findings emphasize the need for comprehensive

management strategies that consider both mental and physical health aspects for individuals with diabetes, especially during crises like COVID-19. This understanding can inform future approaches to healthcare delivery in similar situations, ensuring better preparedness and response to the challenges presented by pandemics.

Conclusion générale

Cette thèse s'est concentrée sur l'analyse de l'accès aux soins de santé dans trois populations vulnérables : les femmes enceintes, les personnes âgées, et les personnes âgées diabétiques. À travers les chapitres, nous avons exploré diverses dimensions de l'accès aux soins, en cherchant à identifier les déterminants des soins prénataux sur la santé des nouveau-nés, à caractériser les renoncements aux soins chez les personnes âgées, et à examiner l'impact de la dépression et de l'isolement social sur la santé des personnes âgées diabétiques pendant la pandémie de COVID-19.

Le premier chapitre a évalué l'effet des soins prénataux appropriés sur la santé des nouveau-nés en France, en utilisant des méthodes de score de propension pour ajuster les facteurs de confusion potentiels. Les résultats ont montré que des soins prénataux adéquats peuvent réduire certains problèmes de santé des nouveau-nés. Cependant, en prenant en compte le comportement des femmes et leurs perceptions de la grossesse, l'effet des soins prénataux sur la santé des nouveau-nés pourrait être nul. Une sous-population de femmes semble utiliser les visites prénatales comme un moyen de s'engager personnellement à adopter de bonnes pratiques de santé plutôt que seulement pour des raisons médicales. Il en ressort que des stratégies d'information, de prévention et de personnalisation des soins prénataux pourraient être plus efficaces et potentiellement économiquement viables.

Le deuxième chapitre a analysé les facteurs associés au renoncement aux soins chez les personnes âgées de plus de 65 ans, ainsi que les différences de consommation

de soins entre celles qui renoncent et celles qui ne renoncent pas. En utilisant l'Enquête sur la Santé et la Protection Sociale de 2012, appariée aux données de l'assurance maladie, nous avons modélisé les dépenses de soins ambulatoires à l'aide d'une régression à changement de régime. Les résultats révèlent que les inégalités sociales et comportementales sont les principaux déterminants du renoncement aux soins. Néanmoins, les déterminants des dépenses de santé restent similaires entre les individus qui renoncent et ceux qui ne renoncent pas, à l'exception de la pré-fragilité et du nombre de maladies chroniques. Aucun effet marginal significatif du renoncement sur les dépenses de santé n'a été observé. La population étudiée présente deux attitudes opposées face à la détérioration de la santé : certains ne déclarent pas de besoins non satisfaits, considérant cette dégradation comme inévitable, tandis que d'autres en déclarent, souhaitant davantage de soins. Nous avons également observé que les personnes inquiètes pour leur avenir signalent plus de besoins non satisfaits, probablement par crainte de la maladie. Ce besoin de réassurance, non pris en compte par le système de santé, pourrait expliquer pourquoi leurs dépenses sont comparables à celles des individus ne demandant pas de soins supplémentaires. Pour répondre à ces besoins non satisfaits, des politiques de santé axées sur l'amélioration de l'accès aux soins préventifs, le soutien psychologique et la personnalisation des soins devraient être mises en œuvre. Ces mesures viseraient à réduire l'insécurité ressentie par les patients en répondant à leur besoin de réassurance tout en évitant une médicalisation excessive.

Le troisième chapitre a exploré l'influence comparative de la dépression sur la détérioration de la santé des personnes âgées, en particulier celles atteintes de diabète, pendant la pandémie de COVID-19. En utilisant des données longitudinales de l'enquête SHARE, et une échelle européenne de dépression, l'étude a montré que la dépression a des effets indirects significatifs sur la détérioration de la santé, tandis que les effets directs du diabète n'étaient pas statistiquement significatifs. Ces

résultats soulignent l'importance de stratégies de gestion intégrées qui abordent à la fois la santé mentale et physique pour soutenir les individus diabétiques lors de crises sanitaires mondiales.

Les résultats de cette thèse ont plusieurs implications pour les politiques de santé publique et les pratiques cliniques. Premièrement, ils mettent en évidence la nécessité de stratégies prénatales personnalisées et de campagnes d'information mieux ciblées pour améliorer la santé des nouveau-nés. Deuxièmement, ils suggèrent que les politiques visant à réduire les inégalités sociales et comportementales pourraient diminuer les besoins non satisfaits parmi les personnes âgées, potentiellement améliorant ainsi leur qualité de vie. Enfin, les résultats démontrent l'importance d'une approche holistique dans la gestion des personnes âgées diabétiques, en particulier pendant des périodes de stress élevé comme la pandémie de COVID-19, où les interventions doivent inclure des aspects de soutien mental en plus des soins médicaux. Bien que cette thèse apporte des contributions significatives, elle comporte certaines limites. La dépendance aux données déclaratives peut introduire des biais de mémoire ou de désirabilité sociale. Les analyses sont basées sur des données disponibles à des moments spécifiques, ce qui peut ne pas capturer pleinement les dynamiques changeantes de la santé et de l'accès aux soins.

Les questions soulevées par cette thèse ouvrent des perspectives de recherche futures diversifiées. Il serait crucial d'examiner l'impact des programmes d'intervention prénatale personnalisée sur des cohortes plus larges et sur des périodes prolongées pour évaluer leur efficacité à long terme. Par ailleurs, il serait bénéfique de se concentrer sur les mécanismes psychologiques et sociaux spécifiques par lesquels les inégalités comportementales influencent la renonciation aux soins, notamment sur le long terme. Enfin, des recherches supplémentaires pourraient explorer les effets conjoints de multiples comorbidités et de la dépression sur la santé des personnes âgées en situation d'isolement, fournissant ainsi des

informations précieuses pour la planification de futures interventions de santé publique.

En conclusion, cette thèse souligne l'importance cruciale de l'accès aux soins pour les populations vulnérables. Les soins prénataux, bien que potentiellement bénéfiques, nécessitent une approche plus ciblée et informée. Les personnes âgées et particulièrement les personnes âgées diabétiques nécessitent des stratégies de soins intégrées qui prennent en compte non seulement leurs besoins médicaux, mais aussi leurs conditions mentales et sociales. Les résultats de cette recherche offrent des opportunités pour améliorer les politiques de santé publique et les pratiques cliniques, contribuant ainsi à une meilleure qualité de vie pour ces populations vulnérables. En abordant les défis identifiés et en capitalisant sur les opportunités découvertes, nous pouvons espérer des améliorations significatives dans l'accès aux soins et la santé globale des groupes étudiés.

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Essai sur le renoncement en économie de la santé

Résumé :

Cette thèse analyse l'accès aux soins de trois populations vulnérables en France : les femmes enceintes, les personnes âgées et les personnes âgées diabétiques. L'objectif est de comprendre les déterminants de cet accès et d'évaluer leur impact sur la santé et la qualité de vie.

Le premier chapitre évalue l'effet des soins prénataux sur la santé des nouveau-nés. Les résultats montrent que des soins adéquats peuvent réduire certains problèmes de santé, mais leur efficacité varie selon les comportements et perceptions des femmes. Une personnalisation des soins prénataux serait plus efficace. Le deuxième chapitre examine les besoins de santé non satisfaits chez les plus de 65 ans. L'étude révèle que les inégalités sociales et comportementales sont des facteurs déterminants. Les dépenses de santé ne diffèrent pas significativement entre ceux déclarant des besoins non satisfaits et les autres, à l'exception de la pré-fragilité et du nombre de pathologies. L'absence d'effet marginal significatif des besoins auto-déclarés sur les dépenses remet en question leur pertinence comme indicateur d'accès aux soins. Le troisième chapitre explore l'impact de la dépression sur la santé des personnes âgées diabétiques pendant la pandémie de COVID-19. La dépression a des effets indirects significatifs sur la détérioration de la santé, tandis que les effets directs du diabète ne sont pas significatifs. Cela met en avant l'importance d'une gestion intégrée de la santé mentale et physique.

En conclusion, la thèse propose des stratégies de soins personnalisées pour améliorer la santé des groupes vulnérables et orienter les politiques publiques

Mots clés : Econométrie appliquée, économie de la santé, renoncement.

Essay on unmet needs in health economy

Summary :

This thesis analyzes healthcare access among three vulnerable populations in France: pregnant women, the elderly, and elderly people with diabetes. The objective is to understand the determinants of healthcare access and assess their impact on health and quality of life.

The first chapter evaluates the effect of prenatal care on newborn health. The results show that adequate prenatal care can reduce certain health issues, although its effectiveness varies depending on the behaviors and perceptions of pregnant women. Personalized prenatal care could be more effective. The second chapter examines unmet healthcare needs among people over 65. The study reveals that social and behavioral inequalities are key determinants. Healthcare spending does not differ significantly between those reporting unmet needs and others, except for pre-frailty and the number of pathologies. The lack of a significant marginal effect of self-reported unmet healthcare needs on spending questions the use of these measurements as an indicator of access to care. The third chapter explores the impact of depression on the health of elderly people with diabetes during the COVID-19 pandemic. Depression has significant indirect effects on health deterioration, while the direct effects of diabetes are not significant. This highlights the importance of integrated management strategies for mental and physical health.

In conclusion, this thesis highlights the challenges and opportunities to improve healthcare access for vulnerable populations, calling for personalized and integrated care strategies to enhance health and quality of life.

Keywords : Applied econometrics, health economics, unmet needs.

Essai sur le renoncement en économie de la santé

Résumé :

Cette thèse analyse l'accès aux soins de trois populations vulnérables en France : les femmes enceintes, les personnes âgées et les personnes âgées diabétiques. L'objectif est de comprendre les déterminants de cet accès et d'évaluer leur impact sur la santé et la qualité de vie.

Le premier chapitre évalue l'effet des soins prénataux sur la santé des nouveau-nés. Les résultats montrent que des soins adéquats peuvent réduire certains problèmes de santé, mais leur efficacité varie selon les comportements et perceptions des femmes. Une personnalisation des soins prénataux serait plus efficace. Le deuxième chapitre examine les besoins de santé non satisfaits chez les plus de 65 ans. L'étude révèle que les inégalités sociales et comportementales sont des facteurs déterminants. Les dépenses de santé ne diffèrent pas significativement entre ceux déclarant des besoins non satisfaits et les autres, à l'exception de la pré-fragilité et du nombre de pathologies. L'absence d'effet marginal significatif des besoins auto-déclarés sur les dépenses remet en question leur pertinence comme indicateur d'accès aux soins. Le troisième chapitre explore l'impact de la dépression sur la santé des personnes âgées diabétiques pendant la pandémie de COVID-19. La dépression a des effets indirects significatifs sur la détérioration de la santé, tandis que les effets directs du diabète ne sont pas significatifs. Cela met en avant l'importance d'une gestion intégrée de la santé mentale et physique.

En conclusion, la thèse propose des stratégies de soins personnalisées pour améliorer la santé des groupes vulnérables et orienter les politiques publiques

Mots clés : Econométrie appliquée, économie de la santé, renoncement.

Essay on unmet needs in health economy

Summary :

This thesis analyzes healthcare access among three vulnerable populations in France: pregnant women, the elderly, and elderly people with diabetes. The objective is to understand the determinants of healthcare access and assess their impact on health and quality of life.

The first chapter evaluates the effect of prenatal care on newborn health. The results show that adequate prenatal care can reduce certain health issues, although its effectiveness varies depending on the behaviors and perceptions of pregnant women. Personalized prenatal care could be more effective. The second chapter examines unmet healthcare needs among people over 65. The study reveals that social and behavioral inequalities are key determinants. Healthcare spending does not differ significantly between those reporting unmet needs and others, except for pre-frailty and the number of pathologies. The lack of a significant marginal effect of self-reported unmet healthcare needs on spending questions the use of these measurements as an indicator of access to care. The third chapter explores the impact of depression on the health of elderly people with diabetes during the COVID-19 pandemic. Depression has significant indirect effects on health deterioration, while the direct effects of diabetes are not significant. This highlights the importance of integrated management strategies for mental and physical health.

In conclusion, this thesis highlights the challenges and opportunities to improve healthcare access for vulnerable populations, calling for personalized and integrated care strategies to enhance health and quality of life.

Keywords : Applied econometrics, health economics, unmet needs.