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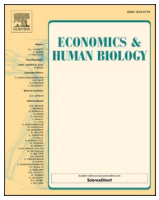

The effects of physical activity prescription on mental health: Evidence from primary care☆

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ABSTRACT

While the benefits of physical activity on health are well documented, in high-income countries 1 in 3 adults do not reach the recommended levels. Thus, policy makers have developed interventions to promote physical activity. The aim of this research is to evaluate the effectiveness of physical activity prescription on mental health outcomes, by studying an intervention that prescribes physical activity at the primary care level in Catalonia (PAFES). This intervention specifically targets the adult population with high cardiovascular risk. We use data from the Health Survey of Catalonia (2011–2016) and exploit the variation in the number of trained General Practitioners that prescribe physical activity. Our results show that physical activity prescription reduces the probability of suffering from poor mental health. This effect is mainly driven by females within the targeted population. We also explore the main effect (or the output) of the intervention. While PAFES increases the probability of patients undertaking high-level physical activity, it does not affect rates of sedentarism or minutes walked per day. Results are consistent when using alternative mental health outcome measures, including self-reported depression and anxiety. We conclude that the prescription of physical activity not only contributes to the improvement of physical health but is also a useful tool to help preserve mental wellbeing.

1. Introduction

The benefits of physical activity (PA) on health and wellbeing are well documented (Jalayondeja et al., 2016; OECD, 2018; WHO, 2018). It helps to prevent diseases such as diabetes, hypertension, overweight and obesity, heart attacks, dementia, depression, anxiety, and some types of cancer (Generalitat de Catalunya, 2023; WHO, 2020). Ensuring a Health Enhancing Physical Activity (HEPA) level across populations is becoming urgent due to the increase in inactivity and sedentarism in our societies. The term "physical inactive" is used to identify individuals who do not get the recommended level of regular physical activity (36 % are inactive in high-income countries (WHO, 2018)) and sedentarism is defined as more than six hours sitting or lying down (except for when sleeping) per day (ESCA, 2021). Reaching high levels of PA can help to improve health and wellbeing for sedentary individuals, even if they continue to live sedentary lifestyles. Current international guidelines recommend a) thirty minutes of moderate PA five days a week, equivalent to a total of 150 minutes, or b) 75 minutes of vigorous activity a week, or c) between 8000 and 10,000 steps a day (WHO, 2020). Factors such as age or chronic ill-health present a barrier to achieving such

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levels for some population groups (Brawley et al., 2003). One strategy to reverse this situation is the prescription of PA in healthcare settings, particularly through primary care prescription programmes.

There is solid evidence of a positive association between the achievement of an adequate level of PA and mental wellbeing. Several empirical strategies have been used to support the positive effect of PA on Mental Health (MH), including reduced form equations, instrumental variables, and simultaneous equations (Kuvaja-Köllner et al., 2013; Lee and Park, 2010; Rasciute and Downward, 2010; Zhang and Chen, 2019). Despite this solid evidence, less than 60 % of women and 70 % of men are physically active in Europe (WHO, 2022). Consequently, PA prescription programmes have been developed to tackle the suboptimal level of PA in societies. Yet, the evidence on the effectiveness of PA *prescription* is limited. The evidence that exists is mainly based on pilots or small-scale interventions, and little is known about what happens when an intervention is scaled up and targets a larger part of the population (Rebar and Taylor, 2017).

Among the initiatives to promote and prescribe PA, in Catalonia (Spain), in 2005, the Department of Health promoted the Plan for the Promotion of Healthy Physical Activity, with an aim to disseminate PA recommendations and achieve higher levels of activity amongst the population. In 2007, they designed the Physical Activity, Sport and Health Plan (PAFES), which aimed to enhance health through advice and prescription of PA in primary care. As a physically active lifestyle prevents and improves the diagnosis of diabetes and other cardiovascular diseases (CVD), PAFES was targeted at the population with high CVD risk. The implementation of this scheme, with non-uniform adoption and a specific target population enables us to utilise methods to causally determine the effect of the primary care prescription of PA on mental health (henceforth, MH). We use a measure to capture the intensity of the PAFES primary care intervention, namely the number of General Physicians (henceforth, GP) per 10,000 inhabitants trained to prescribe PA in a pre-defined area, as an exogenous source of variation to facilitate our analysis. PAFES was designed to prescribe PA to adults with high CVD risk, with the aim of improving their physical health. Improving MH was not one of the policy objectives.

The restricted nature of the PAFES target population, instead of being a shortcoming for our study, presents an opportunity to test the effects amongst a population group that potentially could benefit more from this type of intervention than the general population. The adult population over 40 faces an abrupt jump in the probability of suffering from a chronic condition, and, in particular, from cardiovascular diseases (CVD): with each passing decade, their risk of such an outcome doubles (Fundación Española del Corazón, 2023). This has at least two implications. On the one hand, both older people and people with CVD report lower levels of PA with respect to the younger population or those without CVD (Barker et al., 2019 and Eurostat, 2022), and CVD is the number one cause of death in the European Union (OECD/European Union, 2022) and globally (WHO, 2020). On the other hand, there is evidence that people with a CVD condition have higher probability of poor mental health (i.e., anxiety or depression, due to pain, medication, sudden events, etc. (De Hert et al., 2018). Thus, this paper provides an Intent to Treatment (ITT) analysis for the subsample of the population exposed to the treatment. Our main estimate quantifies the effect of prescribing PA on MH among the population with high CVD risk.International authorities have set specific aims to improve the PA levels of these groups as a cost-effective intervention to tackle poor MH (WHO, 2002; WHO, 2018), in addition to the obvious benefits to physical health.

Our results suggest that PA prescription reduces the probability of suffering poor mental health. This effect is mainly driven by women in the target population (with CVD or diabetes). The intervention analysed, prescription of PAFES, increases the probability of high-level PA, yet it does not affect rates of sedentarism or average minutes walked per day. Results are consistent across alternative outcomes measures, including self-reported depression and anxiety. This paper contributes to several strands of the literature. First, our paper fits into the general field studying the relationship between prescribing PA and MH. By exploiting exogenous variation, i.e., PAFES policy (using the number of GPs trained to prescribe PA), we are able to overcome endogeneity and provide causal estimates. In particular, the analysis contributes to the literature looking at the impact of PA prescription in primary-care settings focusing on a large-scale intervention. Although existing literature discusses the effectiveness of the promotion of physical activity in primary care in different countries (for a review, see Orrow et al., 2013), in most cases these analyses are clinical studies, do not evaluate the causal effect of the policy and have not causally determined the effect of these programmes beyond physical indicators, i.e., well-being. Moreover, our results have a gender dimension, providing novel evidence on the greater benefits achieved by PA prescription for women than men. Second, it contributes to the literature on the (side) effects of people suffering from CVD (Kwapong et al., 2023; Zhang et al., 2015). Third, using a reduced form equation and IV-estimates, we add additional evidence on the benefits of PA on MH. While there is robust evidence on this association (Maynou et al., 2021) our analysis goes one step further by suggesting a causal effect of PA on MH for older-adult and elderly populations, accounting for gender-heterogenous effects. It also contributes to the growing body of literature relating to the promotion of active ageing (Rudnicka et al., 2020).

This paper is structured are follows. In Section 2 we present the dataset, define the policy and describe the identification strategy. In Section 3 the results are reported and in Section 4, we discuss and conclude.

2. Data and methods

2.1. Physical Activity, Sport and Health Plan (PAFES)

In 2005, the Department of Health of Catalonia promoted the Plan for the Promotion of Healthy Physical Activity, with the aim to disseminate PA recommendations and achieve a more active and healthier population. In 2007, an intervention aimed at promoting physical health through advice and the prescription of PA in primary care called PAFES was launched. By encouraging PA, PAFES aimed at better prevention and control of diseases such as CVD, obesity, diabetes mellitus 2 (DM2), colon cancer and osteomuscular diseases. While the PAFES programme started in 2007, the rollout of the programme was gradual and only by 2014 did it incorporate all health management areas (AGA). The training of GPs (intensity) continued throughout the period of analysis, and thus shows variation per AGA and year. This initiative followed examples developed in the Nordic countries and the United Kingdom (UK), who implemented the prescription of PA in primary care centres in the 1990s. The National Institute for Health and Clinical Excellence (NICE) in the UK recommends that primary care professionals advise inactive patients on physical activity (NICE, 2013, 2014).

PAFES main target population is sedentary adults (men over 45 years old and women over 55 years old), with two or more CVDs or with diabetes type 2 (DM2). General Practioners (GPs) (at primary care level) are trained by the Department of Health to identify these individuals at risk and prescribe them PA. For the targeted population, the main PAFES intervention consists of a *6-month supervised programme* (also called Physical Activity Referral Scheme (PARS)) which is provided in collaboration with municipalities. This programme provides advice on the practice of physical exercise in groups of up to 15 people, led by a health specialist technician in local sports facilities. This guided exercise was undertaken 3 days per week in 60-minute sessions. The goal is to make these patients engage and achieve adherence, with the ultimate aim that they will reach high-level of PA as a regular healthy habit (Pardo et al., 2014).

In addition, PAFES offers two other types of prescription for other population groups. First, the sedentary population without impairments

are offered *general advice* from the GP to help them progressively increase PA practice from low to moderate-to-high intensities. Second, for the sedentary population with risk factors and stable chronic diseases, GPs provide an *advised programme* with periodic advice to increase physical activity with progressive goals, promoting the use of public resources such as healthy walking routes.

The PAFES programme has been implemented within the public health system, where GPs are paid on a salary basis. Therefore, there are no financial incentives linked to this policy.

2.2. Data

We draw pooled data from the 2011–2016 waves of the Health Survey of Catalonia (henceforth, ESCA), a representative dataset consisting of 29,692 individuals. ESCA is a cross-section survey collecting, twice a year, information on a wide array of health variables and socioeconomic data of inhabitants in Catalonia, the North-East Region of Spain.

We define three main samples aligned with PAFES prescription (aimed at the adult population, population at risk and PAFES target population) described in the previous section. First, we focus on "adult population", formed of people aged between 18 and 70 years old, which accounts for 18,894 individuals in our database representing 64 % of ESCA observations. The sample is truncated at 70 years old as the physical activity measure (IPAQ) provides only an estimate of physical activity and sedentary behaviour for adults aged 15–69 years-old (Cleland et al., 2018). Second, we define a "population at risk" sample consisting of 10,843 adults aged 40–70 years old, as 40 is considered the age at which the risk of CVD becomes high, and considerably increases with each additional decade (Kantar Health, 2018). Finally, we identify a third sample consisting of the "PAFES target population" (i.e., individuals aged 40–70 years-old and diagnosed with diabetes or a CVD) and formed of 2980 individuals. Note that the PAFES age inclusion criterion is set at 45 years-old for men and 55 years-old for women. However, we use 40 years-old as cut-offs for both genders (following CVD prevalence indicators) to ensure a sufficiently large sample. We exclude 2 % of individuals who are missing key information (in the outcome variables and/or PA level) and a further 9 % because the information of their household status (which is used as a proxy for economic status) is not reported, leaving 16,728, 9656 and 2679 individuals in each sample, respectively.

For each individual, the survey contains a broad range of measures relating to mental wellbeing and the level of physical activity (Appendix 1 presents detailed definitions), in addition to a rich list of controls including health status, healthcare use, labour and household characteristics and lifestyle information. The main measure of mental wellbeing is a dummy taking value 1 if the individual is at risk of poor mental health, according to the answer provided in a reduced and adapted form of the Goldberg Index (General Health Questionnaire), a screening tool employed worldwide to identify minor psychiatric disorders in the general population. The GHQ reduced form is included in the ESCA, and consists of 12 questions (GHQ-12) defined in Appendix 1. The GHQ-12 is easier to administer than longer versions, while having comparable psychometric properties. GHQ-12 aims to capture different features of mental health: auto-perceived level of concentration, capability of decision-making, self-confidence and self-worthiness, among others. The survey includes four answer options that remain constant for each item. E.g.: for the question "Have you recently lost much sleep over worry?", the answers are: "absolutely not", "not more than usual", "a bit more than usual" and "much more than usual". Each answer is transformed in the ESCA dataset to a 0 ("absolutely not" or "not more than usual") or 1 ("a bit more than usual" or "much more than usual") points, up to 12 points. The results are then compared against an established threshold for poor mental health risk (GHQ-12$\geq$3) (ESCA, 2016).

Other measures of mental wellbeing (SWEMWBS, eight-item Patient Health Questionnaire depression scale (PHQ-8) and feeling depressed) are not selected as the main outcomes because they do not have an easy interpretation (SWEMWBS), they are focused in one scope (PHQ-8 and feeling depressed) or are not available for all waves of ESCA reducing the sample size. They are, however, used for the robustness checks. We also explore other indirect outcome measures on healthcare utilisation due to mental health disorders (including visits to a psychologist, psychiatrist, or any doctor) and medical treatment (drugs for antidepressants, sleeping pills and any other medication). All these MH measures have been used in previous studies to identify poor mental health (Maynou et al., 2021).

Other relevant variables, individual characteristics and background variables are included in our preferred specification as control variables to minimize omitted variable bias. The variables are grouped into the following four sets of covariates: individual characteristics, labour market conditions, health status and lifestyle. Within the lifestyle covariate set, we also incorporate a measure of sedentarism and a measure of PA provided by the dataset. Sedentarism takes value 1 if the respondent spent 6 or more hours per day seated. For PA, we use the 7-item International Physical Activity Questionnaire (IPAQ-7) to classify the sample in to three levels of physical activity: high, moderate and low. Roman-Viñas et al. (2010) has validated the IPAQ questionnaire to measure PA among the Spanish population. While sedentarism is used as a control variable in the main specification, the PA measure is only used as a mechanism because it is the objective of the policy. We also test whether sedentarism could be a possible channel by which PA affects MH because we cannot discount the possibility that a sufficiently large level of PA could reduce sedentarism status or that the awareness and education received in the programme might promote a change in sedentarism status.

This dataset is complemented with a variable to capture PAFES implementation, directly drawn from the register of Catalan Public Health Authorities, the institution in charge of PAFES implementation and responsible for GP training. The main explanatory variable accounts for the number of General Practitioners (GP) per 10,000 inhabitants trained under the PAFES programme to prescribe physical activity in each AGA and year.[1]

2.3. Identification strategy and modelling

Our aim is to causally determine the effect of prescribing PA on MH through the PAFES programme. To do so, we exploit the variation across the AGAs over time in the number of trained GPs per 10,000 inhabitants under the PAFES programme. Our data shows that there exists variation across the 43 AGAs. The mean (between 2011 and 2016) is 1 GP trained under PAFES per 10,000 individuals, but the range is from 0 to 5.7, with a median of 0.8. This variable is lagged one-year in our model as the benefits of PA are not immediate and thus the variable captures the probability of being prescribed physical activity the year before the survey. Our main analysis is specified as follows:

$$Y_{it} = \alpha + \beta PAFES_{it-1} + \quad \rho X_{it} \quad + \tau_t + \varepsilon_{it} \tag{1}$$

Where Y_{it} is the MH indicator which equals 1 if the individual is at risk of poor mental health based on her GHQ12 scale; $PAFES_{it-1}$ is the variable that defines the intensity of programme, i.e., the lag of the number of GPs trained per 10,000 inhabitants; X_{it} is a set of covariates (individual characteristics, labour market, household characteristics, health status and lifestyle), τ_t are year fixed-effects and ε_{it} is the error term clustered at the AGA level. The regression is weighted using sample weights. β determines the causal effect of the intervention on MH. This effect is an Intention-to-Treat (ITT) as from our dataset we cannot identify the patients that were prescribed PA, only the patients in the

[1] Information on allocation and characteristics of healthcare professionals in Catalonia can be found here: https://govern.cat/govern/docs/2018/09/19/16/55/96afd35d-81d6-47cf-ae63-02d7b35170a9.pdf.

target group. Even though the outcome variable is binary, we follow an OLS estimation instead of a logistic regression. Our goal is to understand the relationship rather than forecast outcomes. Thus, the choice of OLS is motivated by the ease of estimates' interpretation. As a sensitivity analysis, we present the estimates of the logit regression in the Appendix.

We explore heterogeneous effects by gender given the gender differences in both PA and mental ill-health prevalence identified. In Catalonia, data from the Catalan Health Survey (ESCA, 2021) shows that 36 % of males aged between 15 and 69 years, compared with only 20 % of women, have a healthy level of PA. With MH, women in Catalonia have a higher prevalence of depression compared to males (12.2 % vs 5.7 %) (ESCA, 2021). We run the specification of Equation (1) by gender to explore this heterogeneity.

While MH is the outcome of interest of this research, the direct output of the PAFES intervention is linked to PA level. Pardo et al. (2014) found that the 6-month supervised programme of PAFES, based on a sample of 242 individuals, reduced the number of inactive individuals and produced an adherence that persisted beyond the 6-month programme. This translated into a significant improvement in self-perceived health. This evidence, albeit from a limited pilot study, suggests that one mechanism of PAFES is an enhancement of the level of PA. Our analysis verifies that the PAFES programme had an effect on the level of PA (i.e., effectiveness of the programme) by fitting this specification:

$$PA_{it} = \theta + \varphi PAFES_{it-1} + \quad \lambda X_{it} \quad + \tau_t + \varepsilon_{it} \tag{2}$$

Where PA_{it} is the level of PA defined by the IPAQ indicator (i.e., physically inactive, insufficiently active and active). We also explore gender heterogenous effects for Equation (2). In addition, we also test the effects of PAFES on sedentarism and daily walking minutes as indirect outcomes.

To validate the exogeneity of PAFES with respect to the outcome measure, we present several pieces of evidence. Our preferred specification clusters the standard errors at the AGA level, assuming that our treatment variable captures the territory variation. However, we also provide a specification with territory-year fixed effects in the Appendix (Table A3) to capture any potential unobserved characteristics that might violate our assumption. The results show minimal differences between these specifications. Secondly, concerning the type of patients in the area, which could be another validity threat, we test the random allocation of PAFES by regressing the PAFES variable (i.e., the number of GPs trained per 10,000 inhabitants) on all covariates (X_{it}) and year/territory fixed effects. The results show no significance for each estimated covariate coefficient or the joint significance test. This finding supports the randomness of the PAFES intervention. These results are incorporated in the Appendix, Table A1. We provide additional evidence to support the validity of our identification by running a placebo test which is presented in Section 3.3.

As a robustness check, we validate our findings by using alternative MH outcomes for Equation (1). Although GHQ-12 is a worldwide-employed screening tool that researchers apply to identify minor psychiatric disorders in the general population, the measure involves the subjectivity of individuals' answers. We test the robustness of the results by using alternative mental health outcomes defined in Appendix 1, i.e., self-reported depression and anxiety, diagnosed depression and anxiety, WEMWBS Index, depression index, number of visits to a psychologist, psychiatrist or to any doctor, and prescribed drug consumption.

3. Results

3.1. Descriptive statistics

The summary statistics of MH outcome, PA prescription (intensity of PAFES implementation), individual, labour market and household characteristics, health status and lifestyle (including PA) are presented in Table 1, for the three different samples defined. While 9 % of the adult population are at risk of poor MH, this number increases to 15 % within the target population. The main independent variable of interest averages 1 GP trained to prescribe PA for each 10,000 inhabitants in all three samples.

Table 1
Descriptive Statistics.

	Adult Population N=16,728 (1)	At Risk Population N=9,656 (58%) (2)	Target Population N=2,679 (16%) (3)
Mental Health Outcome			
Risk of poor Mental Health	9 %	10 %	15 %
PA intervention: PAFES			
Number of trained GPs/10,000 inhabitants	0.96	0.98	0.98
Individual Characteristics			
Age (in years)	43	53	58
Female	50 %	50 %	54 %
Immigrant	14 %	9 %	6 %
Couple Household	80 %	80 %	80 %
Poor household habitability	1 %	1 %	1 %
Labour Market Conditions			
Primary Education	12 %	16 %	21 %
Secondary Education	61 %	59 %	56 %
University Education	23 %	19 %	13 %
Unemployed	13 %	11 %	9 %
Student	6 %	0 %	0 %
Retired	7 %	13 %	22 %
Health Status			
1 chronic condition	19 %	17 %	0 %
2 or more chronic conditions	51 %	65 %	100 %
Lack of ADL autonomy	9 %	12 %	22 %
Disability	4 %	7 %	13 %
Lifestyle			
Risky Alcohol Drinker	5 %	3 %	3 %
Overweight or Obese	48 %	59 %	73 %
Smoker	30 %	28 %	23 %
Fruits and Vegetables (+5)	13 %	15 %	16 %
Sedentary	30 %	29 %	29 %
Physically Inactive	30 %	31 %	32 %
Insufficiently Active	56 %	58 %	60 %
Active	14 %	11 %	8 %

Notes: Mental Health Outcome (Risk of poor Mental Health) is a dummy taking value 1 if the individual has a risk of poor mental health, 0 otherwise, according to self-reported answers to the twelve-item General Health Questionnaire (GHQ-12). The last three variables classify the population according to their result in the International Physical Activity Questionnaire (IPAQ-7): low or *Physically Inactive*, moderate or *Insufficiently Active*, and high or *Active*. ADL= Activities of Daily Living (including: personal hygiene, dressing, toileting, transferring and eating).

The target population, compared to the adult population, is older, with a lower rate of immigrants (6 % vs 14 %) and includes a greater proportion of women (54 %). There are no differences in the percentage of those living with a partner (80 %) or those who live in houses with poor levels of habitability (1 %). The target population has a lower level of education, and as expected a larger percentage is retired. While 50 % of the adult population suffer from 2 or more chronic conditions, by definition 100 % of the target population suffer from 2 or more, with at least one of diabetes or CVD. The percentage of the target population who are overweight or obese is 73 %, compared to 48 % of the adult

population. Differences in risky alcohol drinking and eating at least 5 fruits or vegetables per day are less than 3 percentage points (pp). 23 % of people in the target population are smokers compared to 30 % of the adult population.

With respect to the level of the population who are sedentary, the rate is similar across samples. Differences in the physically inactive population are 2 pp. Yet, the percentage of the target population with insufficient levels of PA is 4pp greater than within the adult population, at 60 %; whereas the percentage of active people in the target population is almost half of that in the total population (8 %).

3.2. Effects of PA-intervention on the risk of poor mental health

To identify the causal effect of prescribing PA on ill-mental health, we exploit the variation on the number of GPs trained to prescribe PA per 10,000 inhabitants across the AGAs due to the implementation of PAFES programme.

Table 2 presents the ordinary least square (OLS) estimates on the effect of trained GPs per 10,000 inhabitants on poor mental health, based on the GHQ-12 scale, following the Equation (1) specification. Results report the estimated coefficient for the whole adult population (Column 1), for the at risk population aged 40–70 years old (Column 2) and the PAFES target population defined as the population aged 40–70 with high CVD risk (Column 3). The estimates show that a higher number of GPs trained per 10,000 inhabitants reduced the risk of poor mental health for the three samples (0.7, 0.6 and 1.7 pp respectively). As expected, we observe the greatest effect within the target population. All regressions include a broad set of control variables that present the expected sign (see Appendix 2 Table A2).[2] The PAFES programme appears to have a large impact on mental health across all three samples. Specifically, increasing the rate of PAFES trained physicians leads to a reduction of 11 % in poor mental health for the target population, 7 % for the adult population and 6 % for the at-risk population. [3]

Table 2
Main results.

	Adult Population (1)	At Risk Population (2)	Target Population (3)
Number of trained GPs/ 10,000 inhabitants	−0.0067**	−0.0064**	−0.0167***
	(0.003)	(0.003)	(0.005)
Prevalence of Risk of Poor Mental Health	8.9 %	9.7 %	14.6 %
Observations	16,728	9656	2679
R-squared	0.096	0.117	0.126
Individual Characteristics	Yes	Yes	Yes
Labour Market Conditions	Yes	Yes	Yes
Health Status	Yes	Yes	Yes
Lifestyle	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Cluster	Yes	Yes	Yes

Notes: The dependent variable measures mental health, a dummy taking value 1 if the individual has a risk of poor mental health, 0 otherwise, according to self-reported answers to the twelve-item General Health Questionnaire (GHQ-12). Each column displays OLS estimates from separate weighted regressions, using sampling weights. Column 1 looks at the effect for the whole adult population, Column 2 for at risk population (i.e., those aged between 40 and 70) and Column 3 for target population (PAFES target population +40 with 2+ CVD and/or DM2). Individual Characteristics includes age, gender, migrant status and type of household (HH). Labour market conditions contain education, labour market status and income proxies. Health Status controls for chronic conditions (excluding ill-mental health and CVD or diabetes diseases), disability, and having limitations in Activities of Daily Living (ADL). Lifestyle incorporates covariates on alcohol consumption, being a smoker, being sedentary and eating at least 5 fruits and vegetables per day. Time is measured for every survey wave (there are two waves per natural year). Robust standard errors (in parentheses) are clustered at AGA level. *** indicates 1% significance, ** 5% and * 10%.

For this specification, we provide four sensitivity analyses. First, we include territory-year fixed-effects. Results are reported in Appendix Table A3 and they are in line with Table 2 (magnitude of the coefficients slightly higher). Second, we also replicate the analysis adjusting for PAFES-age threshold for the samples of At Risk Population and Target Population (Tables A4a and A4b). While women are targeted by the PAFES policy at 55 years old, we set the threshold at 40 (see Section 2.2.) to preserve sample size. The inclusion of a larger number of non-affected women (compared to men) may result in attenuation bias for female estimates. Table A4b in the Appendix shows little evidence of attenuation bias led by sample formation, as the age adjusted estimates are less than 1pp larger for females. Third, we estimate the model without the variable poor household habitability because we have other variables to proxy income level in the model, such as education. Omitting the poor household habitability variable increases regression sample size because this information was missing for a sizeable proportion of individuals in our data (from 7.5 % to 9 %, depending on the sample). The coefficient of interest is slightly larger when this control variable is removed for the at risk and target samples (0.7, 0.7 and 1.9 pp respectively for the adult, at risk and target population samples; see Appendix 2 Table A5). Finally, we also run the Table 2 specification with a logistic regression. Results are presented in Table A6 in the Appendix and they are very similar to the ones in Table 2. The logistic estimates are just slightly higher by between 0.2 and 0.4pp.

In addition, we explore heterogeneous effects by gender given the documented gender differences in both PA and mental ill-health prevalence. We present the main estimates in Table 3. We find large heterogeneous effects. For the target population, we find no significant effect of PAFES on poor mental health for men but find a decrease of 3.1 pp amongst women. In contrast, the effects of PAFES for the at-risk population are mainly driven by men (a decrease of 0.7pp). Finally, for the adult population the effects of PAFES are similar for men and women (0. 7 and 0.8 pp, respectively).

Following Equation (2), in order to test for the effectiveness of PAFES intervention comprehensively, we analyse whether it increases the level of PA for all our samples. Table 4 Panel A shows the OLS estimates on the effect of trained GPs per 10,000 inhabitants on PA. Results report the estimated coefficients for the whole adult population (column 1), for the population at risk, aged 40–70 years old (columns 2), and the PAFES target population (columns 3) for the levels of PA physically active. The PA inactive level is presented in Appendix A7. One extra GP trained (per 10,000 inhabitants) is associated with an increase of 1.3 pp active in the target population (0.7 pp for the at risk population). This effect is equivalent to an increase of 16 % in the proportion of the target population who are active. Similarly, the effect for the at risk population is a 6.3 % rise in the proportion who are active. To be consistent, we also

[2] While the PAFES programme is designed to improve PA, it could be thought that the programme might indirectly affect sedentarism. If so, we have removed sedentarism as a control variable and results do not differ from the main regression.

[3] Although the percentage of people with mental health risk is below 15 % in the three samples, and therefore the GHQ12 score is very low (0.66, 0.72 and 1.08 for adult, at risk and target population, respectively), we have estimated the ordinary least square using the score to check if the intensive margin of mental health risk provides additional results. The estimated coefficients lead to similar conclusions as the main results (Table 2).

Table 3
Main results by gender.

	Male Subsample			*Female Subsample*		
	Adult Population (1)	**At Risk Population** (2)	**Target Population** (3)	**Adult Population** (4)	**At Risk Population** (5)	**Target Population** (6)
Number of trained GPs/10,000 inhabitants	−0.0067***	−0.0074***	−0.0000	−0.0076*	−0.0062	−0.0313***
	(0.002)	(0.003)	(0.006)	(0.004)	(0.004)	(0.008)
Prevalence at Risk of Poor Mental Health	6.4 %	6,7 %	9.9 %	11.4 %	12.6 %	19.4 %
Observations	8368	4778	1244	8360	4878	1435
R-squared	0.079	0.103	0.127	0.100	0.116	0.112
Individual Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Labour Market Conditions	Yes	Yes	Yes	Yes	Yes	Yes
Health Status	Yes	Yes	Yes	Yes	Yes	Yes
Lifestyle	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable measures mental health, a dummy taking value 1 if the individual has a risk of poor mental health, 0 otherwise, according to self-reported answers to the twelve-item General Health Questionnaire (GHQ-12). Each column displays OLS estimates from separate weighted regressions, using sampling weights. Columns 1 and 4 looks at the effect for the whole adult population, Columns 2 and 5 for at risk population (i.e. those aged between 40 and 70) and Columns 3 and 6 for target population (PAFES target population +40 with 2+ CVD and/or DM2). Individual Characteristics includes age, migrant status and type of household (HH). Labour market conditions contains education, labour market status and income proxies. Health Status controls for chronic conditions (excluding ill-mental health and CVD or diabetes diseases), disability, and having limitations in Activities of Daily Living (ADL). Lifestyle incorporates covariates on alcohol consumption, being a smoker, being sedentary and eating at least 5 fruits and vegetables per day. Time is measured for every survey wave (there are two waves per natural year). Robust standard errors (in parentheses) are clustered at AGA level. *** indicates 1% significance, ** 5% and * 10%.

check for heterogeneous effects by gender (Panels B and C). As with earlier results, the effects are driven by the female subsample. Results show no effect for males in the at risk and target population. However, we observed a negative effect for the male adult population, which may be driven by the young and healthy men (non-targeted). This might suggest lower positive spillover effects in physical activity engagement for males.

In addition, we have also estimated an IV-regression to test to which extent PA affects MH outcomes. Although, we cannot demonstrate that an exclusion restriction holds, due to the presence of other channels, our IV-estimates support this evidence for the at risk population and target population (see Table A8 in the Appendix).

These estimates suggest that at least one channel through which PAFES intervention improves MH is by enhancing the level of PA among the population. In addition, we test whether PAFES intervention effects sedentarism and no significant effect is found. We further explore if PAFES intervention is associated with an increase in average daily minutes of walking. Following Tudor-Locke et al. (2011), we test whether adults' achieve an average of at least 30 min/day (to reach the 150 min/per week) walking or the recommended 10,000 steps per day (which is equivalent to 75 min/day or 90 min/day, depending on the speed). We do not find any significant result in any of these regressions for either gender sample (see Appendix 2 Table A9). Thus, it seems that PAFES does not impact on sedentary lifestyles but solely increases the level of PA by getting people to increase PA in the supervised programmes. Providing *General advice* to the adult population does not seem to have any significant effect. Similarly, the *Advised programme*, especially promoting healthy walking routes, appears to have little effect as walking minutes have not been significantly increased.

3.3. Placebo and robustness checks

We provide additional evidence to support the validity of our identification strategy, discussed in Section 2.3, by running a placebo test. It is not easy to identify suitable placebo diagnoses, as the prescription of PA is designed to improve physical health, and many diagnoses can be affected. Assuming that a cataract diagnosis is not directly related to physical and mental health, we run equation 1 to show that this diagnosis is not affected by the PAFES programme. Table A10 shows that increasing the number of GPs trained to prescribe PA, does not affect the probability of being diagnosed with cataracts in the Catalan health system.

We also test the robustness of the results by using alternative MH outcomes. Throughout the main analysis we have relied upon data from the GHQ-12 scale to determine whether an individual is at risk of poor mental health.

First, we test the effects of PAFES on suffering anxiety and depression, in addition to outcomes using other mental health scales. Table A11 Panel A in Appendix 2 reports the effects of PAFES on suffering from self-reported depression or anxiety, and having a medical diagnosis of these conditions, which are two of the most prevalent mental health disorders (GBD 2019 Mental Disorders Collaborators, 2022). As with our main outcome, an increase of 1 GP trained for prescribing PA per 10,000 inhabitants significantly reduces the probability of suffering from anxiety or depression, for all samples except for the diagnosis in the target population sample (note that the sample is dramatically reduced in this case as this question was only included for two years of the ESCA). Panel B reports two mental health scales: i) the Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS-14), a recent measure developed to supervise mental wellbeing suitable for use in a general population, and ii) a depression index based on the eight-item Patient Health Questionnaire depression scale (PHQ-8), a measure for the diagnosis and severity of current depression proven to be useful for general population-based studies (Kroenke et al., 2009). While no significant effect is observed for the depression index, the WEMBSE-14 score is positively correlated with the number of GPs trained for prescribing PA, although the number of observations is significantly reduced as this scale was only included in ESCA questionnaires from 2013 to 2016.

Second, we test the effects of PAFES on visits to healthcare for mental health issues. Table A12 Panel A in the Appendix 2, reports no significant effects of PAFES on the number of visits to either any doctor or mental health professionals. To disentangle differences in the effects of PAFES on visits to specific mental-health professionals, Panel B presents separate estimates for visits to psychologists and psychiatrists, and no significant changes are identified.

Third, we check whether PAFES affect the consumption of drugs. Table A13 Panel A, in the Appendix 2, reports the effects of PAFES on consumption of any drugs and those prescribed for mental-health issues. All coefficients have a negative sign, but we identify a significant

Table 4
PAFES on PA active (or High IPAQ level).

	Adult Population (1)	At Risk Population (2)	Target Population (3)
Panel A: Both Genders			
Number of trained GPs/10,000	0.0008	0.0077**	0.0130***
inhabitants	(0.004)	(0.004)	(0.002)
Level of Physical Activity (PA)	14.3 %	11.1 %	7.9 %
Observations	16,728	9656	2679
R-squared	0.088	0.070	0.068
Panel B: Male Subsample			
Number of trained GPs/10,000	−0.0099**	−0.0003	0.0064
inhabitants	(0.005)	(0.005)	(0.006)
Observations	8368	4778	1244
R-squared	0.090	0.070	0.070
Panel C: Female Subsample			
Number of trained GPs/10,000	0.0112**	0.0153***	0.0182***
inhabitants	(0.005)	(0.005	(0.005)
Observations	8360	4878	1435
R-squared	0.050	0.053	0.060
Individual Characteristics.	Yes	Yes	Yes
Labour Market Conditions.	Yes	Yes	Yes
Health Status	Yes	Yes	Yes
Lifestyle	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Cluster	Yes	Yes	Yes

Notes: The dependent variable measures the level of physical activity, a dummy taking value 1 if the individual has a given level of IPAQ, 0 otherwise. Each column displays OLS estimates of the effect of PAFES (measured by the number of trained in PAFES GP every 10,000 inhabitants) on physical activity level from separate weighted regressions, using sampling weights. Columns 1–3 look at the effect of high level of physical activity –what is equivalent to be physical active–, for the whole adult population, at risk population (i.e., those aged between 40 and 70) and target population (PAFES target population +40 with 2+ CVD and/or DM2), respectively. Panel A presents results for the whole sample; Panels B and C for male and females subsamples, respectively. Individual Characteristics includes age, gender, migrant status and type of household (HH). Labour market conditions contains education, labour market status and income proxies. Health Status controls for chronic conditions (excluding ill-mental health and CVD or diabetes diseases), disability and having limitations in Activities of Daily Living (ADL). Lifestyle incorporates covariates on alcohol consumption, being a smoker, being sedentary and eating at least 5 fruits and vegetables per day. Specifications with time-by-territory fixed effects does not change the results. Time is measured for every survey wave (there are two waves per natural year). Robust standard errors (in parentheses) are clustered at health management area (“Area de Gestió Assistencial, AGA’’); there are 43 areas. *** indicates 1% significance, ** 5% and * 10%.

reduction in all-drug consumption for the adult and at risk populations, and also with mental-health drugs for the target population. Hence, an increase in GPs trained for prescribing PA is associated with a reduction of 1.1 pp on the probability of taking mental health drugs. Panel B presents separate estimates for drugs relating to the treatment of depression and those to aid sleep. We observe a significant reduction of 1pp on the probability that people within the target population take drugs to treat depression.

4. Discussion

The objective of this paper was to test the effectiveness of PA prescription on MH. We focused on the PAFES intervention which targets an adult population with high CVD and diabetes risk. To this aim, we exploited the variation in the number of trained GPs that prescribe PA at the primary care level in Catalonia (Spain). The policy design allows us to appropriately study this issue. The policy objective was not to target mental health outcomes, it was only designed to tackle physical health through an exercise programme which suggests exogenity. By showing that there is no joint significance when regressing the variable of the trained GPs on all covariates., we can validly claim that our results are causal estimates. Our hypothesis was that PA prescription enhances MH wellbeing through an increase in PA among those who were not reaching the recommended level of PA.

Our results show that PA prescription reduces the probability of poor mental health. This effect is mainly driven by females within the target population (i.e., with CVD or diabetes). PAFES prescription increases the probability that individuals will reach a high-level of PA, which aligns with results found by Pardo et al. (2014). Yet, it does not affect rates of sedentarism or average minutes walked a day. Results are consistent across alternative outcomes measures, including self-reported depression and anxiety.

Finding significant effects across the whole adult population and the population at risk (aged 40–70) suggests the existence of positive externalities linked to the prescription of PA. While the PAFES programme targets the population with CVD or diabetes, knowledge of the benefits of PA, as well as the ability to prescribe it, could potentially increase the likelihood that trained GPs will prescribe PA to all of their patients. This is helped by a part of PAFES which facilitates a level of PA prescription for the non-target population as explained in Section 2.2. In parallel, there could also be peer effects because the prescribed patients from the targeted population will engage with their family, friends or neighbours. Finally, the spillovers can also be driven by the accessibility to PA-resources (supply of activities, development of green paths, etc.) that were improved by the presence of PAFES activity, as the policy not only involves the Department of Health but also the General Secretary of Sport that works at the municipal level.

The fact that the main effect is driven by females may be led by different facts. Indeed, changes in the level of PA are only significant for the female subsample, which contrast the findings of Pardo et al. (2014) who did not identify significant differences by gender. However, this result is aligned with Martín-Doménech et al. (2021), which evaluates a pilot intervention on PA prescription. They found short-term health benefits after physical activity prescription in primary care, with a higher effect for women on health perception. Moreover, other studies (Campos et al., 2003; Silva-Piñeiro and Mayán-Santos, 2016) found improvements in mental health outcomes primarily among women. These gender differences can be explained by three factors. First, the difference in self-reported health between males and females due to females’ larger prevalence of chronic conditions, in general, and in particular musculoskeletal problems, which are linked to quality of life losses (Malmusi et al., 2011). Second, the literature has shown that females and older people are frequent attenders of primary care providers (Hunt et al., 2011; Smits et al., 2009; Vedsted and Christensen, 2005). Third, it is documented that being a woman and being older are both related to doing less vigorous PA (ESCA, 2021). All of these factors can result in a higher probability of being prescribed PA for women relative to men.

We show that PA prescription improves MH wellbeing because it increases the proportion of the population who are active. Yet, we cannot deny that PA might not be a direct cause of improved MH wellbeing and it could be other aspects of the PAFES intervention that drive this improvement. First, being prescribed PA by the GP may increase the awareness of patients’ need to change towards a healthier lifestyle. This could cause changes in other habits around factors such as nutrition or rest, which can also affect MH wellbeing. Second, the intervention given to the target population involves joining a supervised session with other people, which implicitly has a social component. There exists evidence on the effects of social activity on mental health (Maynou et al., 2021). Similarly, the prescription given to the at-risk population mainly encouraged the use of healthy walking which often would have utilised natural paths. Again, the effects of contact with nature on mental health is well known (Maynou et al., 2021).

This paper contributes to the literature by estimating the effect of PA prescription in primary care on MH. The validity of our approach lies on the fact that PAFES intervention was not aimed at the population with MH diagnosis, but targeted those at risk of CVD and diabetes. From a public health perspective, this positive externality is valuable because the target population has higher risk of poor MH (Ohrnberger et al., 2017) and, indeed, descriptive statistics show that the target population of our sample has higher prevalence of poor MH.

Nevertheless, this research has some caveats linked to the use of survey data. First, we are only able to estimate an ITT effect as we cannot ensure that all adults identified in the target population have been prescribed PA. We cannot tell if GPs are prescribing PA when it is a targeted patient, and neither can we observe if the patients prescribed are in the target group. Second, adherence to PA cannot be confirmed. However, we argue that given these caveats, our positive effects of PA prescription are a lower bound estimate. Third, despite knowing the numbers of trained GPs at each primary care centre, our analysis is done at a more aggregate level, AGA, due to limitations in the survey data.

Finally, regarding policy implications, this paper especially focuses on the main target population of PAFES, namely adults with high CVD and diabetes risk. It is broadly documented that people with chronic conditions are at higher risk of poor mental health. We find that the prescription of PA does not only contribute to improving their physical condition but could become a preventive mechanism that preserves mental wellbeing. As a result, the effect of PA prescription on the targeted populations goes beyond its main objective and positively affects mental well-being as well.

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CRediT authorship contribution statement

Helena M Hernández-Pizarro: Writing – original draft, Project administration, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Laia Maynou:** Writing – original draft, Methodology, Funding acquisition, Formal analysis, Conceptualization.

Conflict of interest

The authors declare no conflict of interest.

Data availability

We can't share data, but data can be asked to catalan health-care authorities

Appendix 1. Variables Definition

The *International Physical Activity Questionnaire* (IPAQ-7) is a highly-reliable set of 7 open-ended questions that allows for international comparison. IPAQ-7 covers leisure-time physical activity, gathering information about 3 dimensions of physical activity: frequency, duration and intensity (measured by days per week: hours and minutes per day). The physical activity reported is weighted by time spent and activity intensity and summed to calculate the Estimated Metabolic Equivalent (MET) of energy expenditure. The resulting estimate is adjusted by age, health status and disability level. These computations allow the classification of physical activity into 3 categories: low (below 600 MET-minutes/week), moderate (at least 600 MET-minutes/week) and high (at least 3000 MET-minutes/week or more). These three categories are understood as follows: high physical activity is equivalent to one daily hour of at least moderate intensity activity level. Moderate physical activity is at the same level of intensity but for a shorter period of time – 30 minutes; and finally, lower physical activity is assigned for those who do not meet any of the other criterions. Until wave 12, the ESCA survey does not include the IPAQ-7 questionnaire but instead an adapted IPAQ questionnaire was included, also allowing the classification of people into the three abovementioned groups of physical activity. In wave 12, the survey contains both sets of question to assess the equivalence.

The *General Health Questionnaire (GHQ)* is a screening tool employed worldwide that researchers apply to identify minor psychiatric disorders in the general population. The short-form is included in the ESCA and it consists of 12 questions (GHQ-12). The survey includes four answer options that remain constant for each item. E.g.: for the question "Have you recently lost much sleep over worry?", the answers are: "absolutely not", "not more than usual", "a bit more than usual" and "much more than usual". GHQ-12 questions (ESCA, 2016). "Have you recently…?"

1. Been able to concentrate on what you're doing?
2. Lost much sleep over worry?
3. Felt you were playing a useful part in things?
4. Felt capable of making decisions about things?
5. Felt constantly under strain?
6. Felt you couldn't overcome your difficulties?
7. Been able to enjoy your normal day-to-day activities?
8. Been able to face up to your problems?
9. Been feeling unhappy and depressed?
10. Been losing confidence in yourself?
11. Been thinking of yourself as a worthless person?
12. Been feeling reasonably happy, all things considered?

As alternative Mental Health Outcomes, we use SWEMBS, PHQ-8 and Feeling Depressed:

- The *Warwick-Edinburgh Mental Wellbeing Scale* (WEMWBS-14) is a recent measure developed to supervise mental wellbeing suitable for use in general population. In particular, we use the shortened version – SWEMWBS-7 – since the seven items included have undergone a more rigorous test for internal consistency than the 14-item scale and have superior scaling properties.[4] The scale is constructed by reporting the tendencies about how often respondents feel sentiments such as optimism, self-usefulness, relaxation, capability of decision-making and problem-solving – among others – over the last two weeks. Lower values are assigned to those individuals who do not feel the indicated mindset any of the time, and higher values to those feeling it all of the time. The difficulties in its interpretation and the low inclusion (only in 3 waves) makes it less suitable to use SWEMWBS-7 as the main outcome variable. While there exists no official thresholds to identify poor mental health, very low scores may be indicative of the need for clinical support.
- The *eight-item Patient Health Questionnaire depression scale (PHQ-8)* is a measure for the diagnosis and severity of current depression, proven to be useful for general population-based studies (Kroenke et al., 2009). It includes 8 questions regarding the frequency in the past 2 weeks that the respondent had experienced a particular depressive symptom, such as having little interest or pleasure in doing things or feeling tired. The four possible answers range from "not at all" to "nearly every day", for which a score of 0–3 is assigned respectively, with the higher indicating more severity of the specific symptom. The sum of the scores for each item yields a total score between 0 and 24 points. A total score of 0–4 denotes no significant depressive symptoms, from 5 to 9 mild depressive symptoms; 10–14, moderate; 15–19, moderately severe; and 20–24, severe. (Kroenke et al., 2001). The PHQ-8 cut-off point for significant depression is defined by a total score $\geq$10.
- Similarly, self-assessed depression mood and anxiety by focusing on respondents' statements that better describe their current health status is also explored. We create a dummy that takes value 1 in cases who report feeling anxious or depressed in some degree, and 0 if not. This variable helps us to capture the general population mental health status instead of focusing on severity levels, which is already covered by the PHQ-8.

Similarly, we also explore indirect mental health outcomes, including:

- Mental Healthcare Use: We study mental health services through medical visits. We first focus on mental health specialists, psychologists and psychiatrists. For each one, we create a dummy taking value 1 in case the individual has visited the specialist at least once within the last year, and 0 otherwise. Also, we combine these measures to create a resulting dummy variable taking value 1 if the individual visited any of the two, and 0 if none of them were visited. By the same construction, we also include a variable considering any medical visit regardless of the doctor's specialization.
- Mental Health drug consumption: We study mental health medication through the consumption of antidepressants and sleep medication. Again, we use independent dummies for each type of medication denoting if the individual has taken the medication over the last two days. Then, we combine these variables to create a third representing the intake of at least one of the two drugs. Finally, we consider any medication intake of any kind. In all the cases, medication consumption does not capture whether the action was prescribed by a doctor, recommended by a pharmacist or self-motivated. This way, where able to cope with both diagnosed and undiagnosed mental disorders.

Appendix 2. Additional Tables

Table A1
Validity of PAFES

	Target Population
Age	−0.0067
	(0.009)
Age^2	0.0000
	(0.000)
Female	0.0072
	(0.007)
Immigrant	−0.0014
	(0.017)
Couple HH	0.0001
	(0.012)
Primary Education	−0.0231
	(0.018)
Secundary Education	−0.0089
	(0.015)
University Education	−0.0253
	(0.026)
Unemployed	0.0121
	(0.017)
Student	0.0479
	(0.107)
Retired	−0.0051
	(0.013)
Poor HH habitability	−0.0455
	(0.052)
Lack of autonomy ADL	−0.0032
	(0.017)
Disabled	0.0256

(*continued on next page*)

[4] Warkick Medical School - https://warwick.ac.uk/fac/med/research/platform/wemwbs/development/swemwbs/

Table A1 (*continued*)

	Target Population
	(0.021)
Risky Alcohol Drinker	0.0065
	(0.029)
Overweight or Obese	0.0087
	(0.009)
Smoker	−0.0003
	(0.009)
Fruits and Vegetables (+5)	0.0246*
	(0.014)
Sedentary	−0.0038
	(0.015)
Observations	2679
R-squared	0.939
F-test (p-value)	0.89 (0.60)
Individual Caractheristics	Yes
Labour Market Conditions	Yes
Health Status	Yes
Lifestyle	Yes
Year FE	Yes
Territory/AGA FE	Yes

Notes: The dependent variable measures the number of trained in PAFES GP every 10,000 inhabitants. Each column displays OLS estimates from separate weighted regressions, using sampling weights. Column 1 looks at the effect for the whole adult population, Column 2 for at risk population (i.e. those aged between 40 and 70) and Column 3 for target population (PAFES target population +40 with 2+ CVD and/or DM2). Individual Characteristics includes age, gender, migrant status and type of household (HH). Labour market conditions contains education, labour market status and income proxies. Health Status controls for chronic conditions (excluding ill-mental health and CVD or diabetes diseases), disability, and having limitations in Activities of Daily Living (ADL). Lifestyle incorporates covariates on alcohol consumption, being a smoker, being sedentary and eating at least 5 fruits and vegetables per day. Time is measured for every survey wave (there are two waves per natural year) and AGA fixed-effects are included. Robust standard errors (in parentheses). *** indicates 1% significance, ** 5% and * 10%.

Table A2
Main Results – all covariates

	Adult Population (1)	At Risk Population (2)	Target Population (3)
Number of trained GPs/10,000 inhabitants	−0.0067**	−0.0064**	−0.0167***
	(0.003)	(0.003)	(0.005)
Age	0.0028*	0.0086	0.0170
	(0.001)	(0.006)	(0.015)
Age^2	−0.0000**	−0.0001*	−0.0002
	(0.000)	(0.000)	(0.000)
Female	0.0409***	0.0529***	0.0976***
	(0.004)	(0.004)	(0.006)
Immigrant	−0.0006	0.0015	0.0240
	(0.008)	(0.011)	(0.039)
Couple HH	−0.0264***	−0.0295***	−0.0372*
	(0.006)	(0.008)	(0.020)
Primary Education	−0.0354**	−0.0236	−0.0196
	(0.014)	(0.018)	(0.030)
Secondary Education	−0.0434***	−0.0423***	−0.0338
	(0.012)	(0.014)	(0.025)
University Education	−0.0558***	−0.0544***	−0.0481
	(0.012)	(0.014)	(0.029)
Unemployed	0.0685***	0.0794***	0.0828***
	(0.007)	(0.010)	(0.026)
Student	0.0287***	−0.0899***	−0.0990***
	(0.010)	(0.017)	(0.032)
Retired	−0.0095	0.0050	0.0115
	(0.008)	(0.009)	(0.019)
Poor HH habitability	0.0596**	0.0803**	0.1510*
	(0.025)	(0.036)	(0.082)
1 chronic condition	0.0184***	0.0128**	
	(0.004)	(0.006)	
2 or more chronic conditions	0.0794***	0.0736***	
	(0.006)	(0.007)	
Lack of autonomy ADL	0.1861***	0.1948***	0.2105***
	(0.016)	(0.014)	(0.021)
Disabled	0.0443***	0.0520***	0.0327
	(0.014)	(0.015)	(0.026)
Risky Alcohol Drinker	0.0426***	0.0294	0.0553
	(0.011)	(0.021)	(0.041)
Overweight or Obese	0.0089*	0.0118*	0.0098
	(0.005)	(0.006)	(0.014)
Smoker	0.0154***	0.0135*	0.0077

(*continued on next page*)

Table A2 (*continued*)

	Adult Population (1)	At Risk Population (2)	Target Population (3)
	(0.005)	(0.008)	(0.020)
Fruits and Vegetables (+5)	−0.0123*	−0.0175**	−0.0288
	(0.007)	(0.008)	(0.020)
Sedentary	0.0038	0.0159**	0.0273*
	(0.006)	(0.006)	(0.014)
Prevalence of Risk of Poor Mental Health	8.9 %	9.7 %	14.6 %
Observations	16.728	9.656	2.679
R-squared	0.096	0.117	0.126
Individual Characteristics	Yes	Yes	Yes
Labour Market Conditions	Yes	Yes	Yes
Health Status	Yes	Yes	Yes
Lifestyle	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Cluster	Yes	Yes	Yes

Notes: The dependent variable measures mental health, a dummy taking value 1 if the individual has a risk of poor mental health, 0 otherwise, according to self-reported answers to the twelve-item General Health Questionnaire (GHQ-12). Each column displays OLS estimates from separate weighted regressions, using sampling weights. Column 1 looks at the effect for the whole adult population, Column 2 for at risk population (i.e. those aged between 40 and 70) and Column 3 for target population (PAFES target population +40 with 2+ CVD and/or DM2). Individual Characteristics includes age, gender, migrant status and type of household (HH). Labour market conditions contains education, labour market status and income proxies. Health Status controls for chronic conditions (excluding ill-mental health and CVD or diabetes diseases), disability, and having limitations in Activities of Daily Living (ADL). Lifestyle incorporates covariates on alcohol consumption, being a smoker, being sedentary and eating at least 5 fruits and vegetables per day. Time is measured for every survey wave (there are two waves per natural year). Robust standard errors (in parentheses) are clustered at AGA level. *** indicates 1% significance, ** 5% and * 10%.

Table A3
Main results with year-region fixed-effects

	Adult Population (1)	At Risk Population (2)	Target Population (3)	Adult Population (4)	At Risk Population (5)	Target Population (6)
Panel A: ***Both Genders***						
Number trained GP/10 000 inhabitants	−0.0019***	−0.0019	−0.0671***			
	(0.001)	(0.002)	(0.005)			
Observations	16,728	9656	2679			
R-squared	0.129	0.162	0.252			
Panel B: ***By Gender***	***Male Subsample***			***Female Subsample***		
Number trained GP/10 000 inhabitants	−0.0044	−0.0453***	0.0470**	−0.0367***	−0.0306***	−0.0538***
	(0.003)	(0.003)	(0.020)	(0.002)	(0.004)	(0.019)
Observations	8368	4778	1244	8360	4878	1435
R-squared	0.130	0.172	0.333	0.154	0.199	0.346
Individual Caractheristics	Yes	Yes	Yes	Yes	Yes	Yes
Labour Market Conditions	Yes	Yes	Yes	Yes	Yes	Yes
Health Status	Yes	Yes	Yes	Yes	Yes	Yes
Lifestyle	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Region/AGA FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable measures mental health, a dummy taking value 1 if the individual has a risk of poor mental health, 0 otherwise, according to self-reported answers to the twelve-item General Health Questionnaire (GHQ-12). Each column displays OLS estimates from separate weighted regressions, using sampling weights. Columns 1 and 4 look at the effect for the whole adult population, Column 2 and 5 for at risk population (i.e. those aged between 40 and 70) and Column 3 and 6 for target population (PAFES target population +40 with 2+ CVD and/or T2D). Panel A looks at the whole population while Panel B presents the results by gender. Individual Characteristics includes age, gender, migrant status and type of household (HH). Labour and HH Characteristics groups contains education, labour market status and income proxies. Health Status controls for chronic conditions (excluding ill-mental health and CVD or diabetes diseases), disability and having limitations in Activitities of Daily Living (ADL). Lifestyle incorporates covariates on alcohol consumption, being a smoker and eating at least 5 fruits and vegetables per day. Specifications with time-by-territory fixed effects does not change the results. Time is measured for every survey wave (there are two waves per natural year). The specification include year and Territory/AGA fixed-effects and the interaction of year and AGA fixed-effects. Robust standard errors (in parentheses) are clustered at AGA. *** indicates 1% significance, ** 5% and * 10%.

Table A4a
Results for samples adjusted by age PAFES definition

	At Risk Population (1)	Target Population (2)
Number trained GP/10,000 inhabitants	−0.0072**	−0.0143***
	(0.003)	(0.004)
Observations	5951	2679
R-squared	0.124	0.126
Individual Caractheristics	Yes	Yes
Labour Market Conditions	Yes	Yes
Health Status	Yes	Yes
Lifestyle	Yes	Yes
Year FE	Yes	Yes
Cluster	Yes	Yes

Notes: The dependent variable measures mental health, a dummy taking value 1 if the individual has a risk of poor mental health, 0 otherwise, according to self-reported answers to the twelve-item General Health Questionnaire (GHQ-12). Each column displays OLS estimates from separate weighted regressions, using sampling weights. Columns 1 and 2 present the estimates re-defining the two population groups: At Risk Population group (i.e. women aged between 55 and 70 and men aged between 45 and 70) and Target Population (i.e. women aged between 55 and 70 and men aged between 45 and 70 with 2+ CVD and/or T2D). Individual Characteristics includes age, gender, migrant status and type of household (HH). Labour and HH Characteristics groups contains education, labour market status and income proxies. Health Status controls for chronic conditions (excluding ill-mental health and CVD or diabetes diseases), disability, and having limitations in Activities of Daily Living (ADL). Lifestyle incorporates covariates on alcohol consumption, being a smoker, being sedentarian and eating at least 5 fruits and vegetables per day. Time is measured for every survey wave (there are two waves per natural year). Robust standard errors (in parentheses) are clustered at AGA level. *** indicates 1% significance, ** 5% and * 10%.

Table A4b
Results for samples adjusted by age PAFES definition by gender

	Male Subsample		*Female Subsample*	
	At risk Population (1)	Target Population (2)	At risk Population (3)	Target Population (4)
Number trained GP/10,000 inhabitants	−0.0060**	0.0015	−0.0086	−0.0326***
	(0.003)	(0.006)	(0.006)	(0.009)
Observations	3762	1159	2189	971
R-squared	0.106	0.136	0.137	0.132
Individual Caractheristics	Yes	Yes	Yes	Yes
Labour Market Conditions	Yes	Yes	Yes	Yes
Health Status	Yes	Yes	Yes	Yes
Lifestyle	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Cluster	Yes	Yes	Yes	Yes

Notes: The dependent variable measures mental health, a dummy taking value 1 if the individual has a risk of poor mental health, 0 otherwise, according to self-reported answers to the twelve-item General Health Questionnaire (GHQ-12). Each column displays OLS estimates from separate weighted regressions, using sampling weights. Columns 1–4 present the estimates re-defining the two population groups: At Risk Population group (i.e. women aged between 55 and 70 and men aged between 45 and 70) and Target Population (i.e. women aged between 55 and 70 and men aged between 45 and 70 with 2+ CVD and/or T2D) for males (Columns 1 and 2) and for females (Columns 3 and 4). Individual Characteristics includes age, gender, migrant status and type of household (HH). Labour and HH Characteristics groups contains education, labour market status and income proxies. Health Status controls for chronic conditions (excluding ill-mental health and CVD or diabetes diseases), disability, and having limitations in Activitities of Daily Living (ADL). Lifestyle incorporates covariates on alcohol consumption, being a smoker, being sedentarian and eating at least 5 fruits and vegetables per day. Time is measured for every survey wave (there are two waves per natural year). Robust standard errors (in parentheses) are clustered at AGA level. *** indicates 1% significance, ** 5% and * 10%.

Table A5
Main results - drop poor habitability control

	Adult Population (1)	At Risk Population (2)	Target Population (3)
Number of trained GPs/10,000 inhabitants	−0.0070***	−0.0072***	−0.0185***
	(0.002)	(0.003)	(0.005)
Observations	18,453	10,588	2898
R-squared	0.096	0.117	0.125
Individual Characteristics	Yes	Yes	Yes
Labour Market Conditions	Yes	Yes	Yes
Health Status	Yes	Yes	Yes
Lifestyle	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Cluster	Yes	Yes	Yes

Notes: The dependent variable measures mental health, a dummy taking value 1 if the individual has a risk of poor mental health, 0 otherwise, according to self-reported answers to the twelve-item General Health Questionnaire (GHQ-12). Each column displays OLS estimates from separate weighted regressions, using

sampling weights. Column 1 looks at the effect for the whole adult population, Column 2 for at risk population (i.e., those aged between 40 and 70) and Column 3 for target population (PAFES target population +40 with 2+ CVD and/or DM2). Individual Characteristics includes age, gender, migrant status and type of household (HH). Labour market conditions contains education and labour market status. Health Status controls for chronic conditions (excluding ill-mental health and CVD or diabetes diseases), disability, and having limitations in Activities of Daily Living (ADL). Lifestyle incorporates covariates on alcohol consumption, being a smoker, being sedentary and eating at least 5 fruits and vegetables per day. Time is measured for every survey wave (there are two waves per natural year). Robust standard errors (in parentheses) are clustered at AGA level. *** indicates 1% significance, ** 5% and * 10%.

Table A6
Main results with logistic regression

	Adult Population (1)	At Risk Population (2)	Target Population (3)
Number trained GP/10,000 inhabitants	−0.0083**	−0.0082**	−0.0208***
	(0.004)	(0.004)	(0.007)
Observations	16,728	9649	2676
Individual Caractheristics	Yes	Yes	Yes
Labour Market Conditions	Yes	Yes	Yes
Health Status	Yes	Yes	Yes
Lifestyle	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Cluster	Yes	Yes	Yes

Notes: The dependent variable measures mental health, a dummy taking value 1 if the individual has a risk of poor mental health, 0 otherwise, according to self-reported answers to the twelve-item General Health Questionnaire (GHQ-12). Each column displays AME estimates from a logistic regression from separate weighted regressions, using sampling weights. Column 1 looks at the effect for the whole adult population, Column 2 for at risk population (i.e. those aged between 40 and 70) and Column 3 for target population (PAFES target population +40 with 2+ CVD and/or T2D). Individual Characteristics includes age, gender, migrant status and type of household (HH). Labour and HH Characteristics groups contains education and labour market status. Health Status controls for chronic conditions (excluding ill-mental health and CVD or diabetes diseases), disability, and having limitations in Activitities of Daily Living (ADL). Lifestyle incorporates covariates on alcohol consumption, being a smoker, being sedentarian and eating at least 5 fruits and vegetables per day. Time is measured for every survey wave (there are two waves per natural year). Robust standard errors (in parentheses) are clustered at AGA level. *** indicates 1% significance, ** 5% and * 10%.

Table A7
PAFES on PA inactive (or Low IPAQ level)

	Adult Population (1)	At Risk Population (2)	Target Population (3)
Panel A: *Both Genders*			
Number of trained GPs/10,000 inhabitants	0.0160	0.0176*	0.0079
	(0.010)	(0.010)	(0.008)
Level of Physical Activity (PA)	30.2 %	31.3 %	32.1 %
Observations	16,728	9656	2679
R-squared	0.066	0.069	0.097
Panel B: *Male Subsample*			
Number of trained GPs/10,000 inhabitants	0.0149	0.0197	0.0119
	(0.010)	(0.012)	(0.010)
Observations	8368	4778	1244
R-squared	0.068	0.069	0.110
Panel C: *Female Subsample*			
Number of trained GPs/10,000 inhabitants	0.0171	0.0160	0.0061
	(0.011)	(0.011)	(0.014)
Observations	8360	4878	1435
R-squared	0.062	0.070	0.101
Individual Characteristics.	Yes	Yes	Yes
Labour Market Conditions.	Yes	Yes	Yes
Health Status	Yes	Yes	Yes
Lifestyle	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Cluster	Yes	Yes	Yes

Notes: The dependent variable measures the level of physical inactivity, a dummy taking value 1 if the individual has a IPAQ low level, 0 otherwise. Each column displays OLS estimates of the effect of PAFES (measured by the number of trained in PAFES GP every 10,000 inhabitants) on physical inactivity level from separate weighted regressions, using sampling weights. Columns 1–3 look at the effect of low level of physical activity – what is equivalent to be physical inactive –, for the whole adult population, at risk population (i.e., those aged between 40 and 70) and target population (PAFES target population +40 with 2+ CVD and/or DM2), respectively. Panel A presents results for the whole sample; Panels B and C for male and females subsamples, respectively. Individual Characteristics includes age, gender, migrant status and type of household (HH). Labour market conditions contains education, labour market status and income proxies. Health Status controls for chronic conditions (excluding ill-mental health and CVD or diabetes diseases), disability and having limitations in Activities of Daily Living (ADL). Lifestyle incorporates covariates on alcohol consumption, being a smoker, being sedentary and eating at least 5 fruits and vegetables per day. Specifications with time-by-territory fixed effects do not change the results. Time is measured for every survey wave (there are two waves per natural year). Robust standard errors (in parentheses) are

clustered at health management area ("Area de Gestió Assistencial, AGA"); there are 43 areas. *** indicates 1% significance, ** 5% and * 10%.

Table A8
Main results – IV

	Adult Population (1)	At Risk Population (2)	Target Population (3)
Panel A. First stage			
Number trained GP/10,000 inhabitants	0.0008	0.0077**	0.0130**
	(0.003)	(0.003)	(0.006)
F-test (on IV)	41.86	17.41	4.4
Panel B. IV-Results			
Active (high level of IPAQ)	−8.6837	−0.8297*	−1.2856*
	(32.273)	(0.501)	(0.758)
Observations	16,728	9656	2679
Individual Caractheristics	Yes	Yes	Yes
Labour Market Conditions	Yes	Yes	Yes
Health Status	Yes	Yes	Yes
Lifestyle	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Notes: Each column displays 2SLS estimates from separate weighted regressions, using sampling weights. Column 1 looks at the effect for the whole adult population, Column 2 for at risk population (i.e. those aged between 40 and 70) and Column 3 for target population (PAFES target population +40 with 2+ CVD and/or T2D). Panel A shows First Stage, where the dependent variable is dummy, which equals 1 if the person is physically active (high level of IPAQ) and 0 otherwise. The third row of the panel presents the F-test on the IV. Panel B presents IV-results. The dependent variable measures mental health, a dummy taking value 1 if the individual has a risk of poor mental health, 0 otherwise, according to self-reported answers to the twelve-item General Health Questionnaire (GHQ-12). Individual Characteristics includes age, gender, migrant status and type of household (HH). Labour and HH Characteristics groups contains education, labour market status and income proxies. Health Status controls for chronic conditions (excluding ill-mental health and CVD or diabetes diseases), disability, and having limitations in Activitities of Daily Living (ADL). Lifestyle incorporates covariates on alcohol consumption, being a smoker, being sedentarian and eating at least 5 fruits and vegetables per day. Time is measured for every survey wave (there are two waves per natural year). Robust standard errors (in parentheses) are clustered at AGA level. *** indicates 1% significance, ** 5% and * 10%.

Table A9
Effects of PAFES on sedentarism and/or average walking minutes

	Sedentarism			***30 min walking/per day or more*** (reaching 150 min per week)			***10,000 steps a day or more*** (75 min walking or more, at high speed)			***10,000 steps a day or more*** (90 min walking or more, at low speed)		
	Adult Population (1)	**At Risk Population** (2)	**Target Population** (3)	**Adult Population** (4)	**At Risk Population** (5)	**Target Population** (6)	**Adult Population** (7)	**At Risk Population** (8)	**Target Population** (9)	**Adult Population** (10)	**At Risk Population** (11)	**Target Population** (12)
Panel A: *Both genders*												
Num trained GP/10 000 inhabitants	0.0002	−0.0048	−0.0128	−0.0132	−0.0086	0.0004	−0.0017	0.0008	0.0079	−0.0014	0.0007	0.0045
	(0.008)	(0.009)	(0.011)	(0.010)	(0.010)	(0.008)	(0.003)	(0.004)	(0.008)	(0.003)	(0.004)	(0.007)
Observations	14,101	8232	2135	15,010	8848	2287	15,010	8848	2287	15,010	8848	2287
R-squared	0.077	0.060	0.062	0.042	0.051	0.056	0.030	0.035	0.037	0.028	0.033	0.033
Panel B: *Male Subsample*												
Num trained GP/10 000 inhabitants	−0.0048	−0.0090	−0.0238	−0.0091	−0.0086	−0.0059	−0.0018	0.0026	0.0051	−0.0016	0.0025	0.0018
	(0.008)	(0.010)	(0.019)	(0.011)	(0.015)	(0.012)	(0.003)	(0.004)	(0.010)	(0.003)	(0.004)	(0.009)
Observations	8368	4778	1244	8808	5066	1319	8808	5066	1319	8808	5066	1319
R-squared	0.095	0.075	0.070	0.046	0.056	0.062	0.032	0.037	0.042	0.030	0.035	0.040
Panel C: *Female Subsample*												
Num trained GP/10 000 inhabitants	0.0101	0.0048	0.0056	−0.0161	−0.0122	0.0015	−0.0036	−0.0037	0.0077	−0.0036	−0.0039	0.0055
	(0.009)	(0.009)	(0.009)	(0.010)	(0.010)	(0.014)	(0.005)	(0.005)	(0.009)	(0.005)	(0.005)	(0.009)
Observations	8360	4878	1435	8829	5206	1512	8829	5206	1512	8829	5206	1512
R-squared	0.071	0.065	0.099	0.038	0.045	0.062	0.019	0.023	0.035	0.018	0.022	0.033
Individual Caractheristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Labour Market Conditions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Health Status	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lifestyle	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Each column displays OLS estimates of the effect of PAFES (measured by the number of trained in PAFES GP every 10 000 inhabitants) on sedentarism or average min walking per day from separate weighted regressions, using sampling weights. Columns 1, 4, 7 and 10 present the estimates for adult population. Columns 2, 5,8 and 11 provide the effects of the population at risk; and columns 3, 6, 9 and 12 for the target population. Panel A presents the results form both genders, Panel B for males and Panel C for females. Individual Characteristics includes age, migrant status and type of household (HH). Labour and HH Characteristics groups contains education, labour market status and income proxies. Health Status controls for chronic conditions (excluding ill-mental health and CVD or diabetes diseases), disability and having limitations in Activitities of Daily Living (ADL). Lifestyle incorporates covariates on alcohol consumption, being smoker and eating at least 5 fruits and vegetables per day. Specifications with time-by-territory fixed effects does not change the results. Time is measured for every survey wave (there are two waves per natural year). Robust standard errors (in parentheses) are clustered at health management area ("Area de Gestió Assistencial, AGA"); there are 43 areas. *** indicates 1% significance, ** 5% and * 10%.

Table A10
Placebo test: Cataracts

	Adult Population (1)	**At Risk Population** (2)	**Target Population** (3)	**Adult Population** (4)	**At Risk Population** (5)	**Target Population** (6)
Panel A: *Both Genders*						
Number trained GP/10 000 inhabitants	−0.0013	−0.0010	−0.0016			
	(0.001)	(0.002)	(0.005)			
Observations	16,728	9656	2679			
R-squared	0.109	0.110	0.111			
Panel B: *By Gender*	***Male Subsample***			***Female Subsample***		
Number trained GP/10 000 inhabitants	−0.0023	−0.0028	−0.0041	−0.0002	0.0009	−0.0000
	(0.002)	(0.003)	(0.007)	(0.002)	(0.003)	(0.007)
Observations	8368	4778	1244	8360	4878	1435
R-squared	0.097	0.099	0.094	0.123	0.123	0.133
Individual Caractheristics	Yes	Yes	Yes	Yes	Yes	Yes
Labour Market Conditions	Yes	Yes	Yes	Yes	Yes	Yes
Health Status	Yes	Yes	Yes	Yes	Yes	Yes
Lifestyle	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Region/AGA FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable measures cataracts' diagnosis, a dummy taking value 1 if the individual has a diagnosis of cataracts, 0 otherwise. Each column displays OLS estimates from separate weighted regressions, using sampling weights. Columns 1 and 4 look at the effect for the whole adult population, Column 2 and 5 for at risk population (i.e. those aged between 40 and 70) and Column 3 and 6 for target population (PAFES target population +40 with 2+ CVD and/or T2D). Panel A looks at the whole population while Panel B presents the results by gender. Individual Characteristics includes age, gender, migrant status and type of household (HH). Labour and HH Characteristics groups contains education, labour market status and income proxies. Health Status controls for chronic conditions (excluding ill-mental health and CVD or diabetes diseases), disability and having limitations in Activitities of Daily Living (ADL). Lifestyle incorporates covariates on alcohol consumption, being sedentarian, being a smoker and eating at least 5 fruits and vegetables per day. Time is measured for every survey wave (there are two waves per natural year). Robust standard errors (in parentheses) are clustered at AGA level. *** indicates 1% significance, ** 5% and * 10%.

Table A11
Alternative Outcomes: Depression and Anxiety self-reported and diagnosis, and other MH scales

	Adult Population (1)	**At Risk Population** (2)	**Target Population** (3)	**Adult Population** (4)	**At Risk Population** (5)	**Target Population** (6)
Panel A: Dependent Variables	***Depression and Anxiety self-reported***			***Depression and Anxiety diagnosis***		
Number of trained GPs/10,000 inhabitants	−0.0128***	−0.0136***	−0.0177***	−0.0116***	−0.0133**	−0.0134
	(0.003)	(0.004)	(0.006)	(0.004)	(0.005)	(0.024)
Observations	16,728	9656	2679	2657	1610	381
R-squared	0.182	0.188	0.198	0.183	0.182	0.189
Panel B: Dependent Variables	***WEMWBS Index***			***Depression Index***		
Number of trained GPs/10,000 inhabitants	0.2662***	0.2848***	0.4343***	−0.0024	0.0004	0.0064
	(0.097)	(0.103)	(0.151)	(0.003)	(0.004)	(0.008)
Observations	11,389	6638	1723	16,728	9656	2679
R-squared	0.166	0.188	0.231	0.182	0.192	0.181
Individual Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Labour Market Conditions	Yes	Yes	Yes	Yes	Yes	Yes
Health Status	Yes	Yes	Yes	Yes	Yes	Yes
Lifestyle	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Panel A reports the estimates for self-reported and diagnosis or Depression and Anxiety. Panel B reports the estimates of two scales: the Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS) and Depression Scale Patient Health Questionnaire (PHQ8). Columns 1 and 4 present the estimates for adult population. Columns 2 and 5 provide the effects of the population at risk; and columns 3 and 6 for the target population. Individual Characteristics includes age, gender, migrant status and type of household (HH). Labour market conditions contains education, labour market status and income proxies. Health Status controls for chronic conditions (excluding ill-mental health and CVD or diabetes diseases), disability and having limitations in Activities of Daily Living (ADL). Lifestyle incorporates covariates on alcohol consumption, being a smoker and eating at least 5 fruits and vegetables per day. Specifications with time-by-territory fixed effects do not change the results. Time is measured for every survey wave (there are two waves per natural year). Robust standard errors (in parentheses) are clustered at health management area (“Area de Gestió Assistencial, AGA’’); there are 43 areas.*** indicates 1% significance, ** 5% and * 10%.

Table A12
Alternative Outcomes: visits to psychologist, psychiatrist or any doctor

	Adult Population (1)	At Risk Population (2)	Target Population (3)	Adult Population (4)	At Risk Population (5)	Target Population (6)
Panel A: Dependent Variables	***Any Doctor***			***Psychologist or Psychiatrist***		
Number of trained GPs/10,000 inhabitants	0.0066**	0.0026	0.0007	−0.0033*	−0.0009	−0.0044
	(0.003)	(0.002)	(0.004)	(0.002)	(0.002)	(0.003)
Observations	16,728	9656	2679	16,728	9656	2679
R-squared	0.098	0.110	0.125	0.081	0.089	0.037
Panel B: Dependent Variables	***Psychologist***			***Psychiatrist***		
Number of trained GPs/10,000 inhabitants	−0.0030**	0.0012	−0.0032	−0.0021	−0.0015	−0.0025
	(0.001)	(0.001)	(0.003)	(0.002)	(0.002)	(0.003)
Observations	16,728	9656	2679	16,728	9656	2679
R-squared	0.055	0.067	0.085	0.108	0.115	0.123
Individual Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Labour Market Conditions	Yes	Yes	Yes	Yes	Yes	Yes
Health Status	Yes	Yes	Yes	Yes	Yes	Yes
Lifestyle	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Panel A reports the estimates for mental-health healthcare professionals and any doctor. Panel B reports the estimates for psychologist and psychiatrist to disentangle effects of these two different professionals. Columns 1 and 4 present the estimates for adult population. Columns 2 and 5 provide the effects of the population at risk; and columns 3 and 6 for the target population. Individual Characteristics includes age, gender, migrant status and type of household (HH). Labour market conditions contains education, labour market status and income proxies. Health Status controls for chronic conditions (excluding ill-mental health and CVD or diabetes diseases), disability and having limitations in Activities of Daily Living (ADL). Lifestyle incorporates covariates on alcohol consumption, being a smoker and eating at least 5 fruits and vegetables per day. Specifications with time-by-territory fixed effects do not change the results. Time is measured for every survey wave (there are two waves per natural year). Robust standard errors (in parentheses) are clustered at health management area (“Area de Gestió Assistencial, AGA’’); there are 43 areas. *** indicates 1% significance, ** 5% and * 10%.

Table A13
Alternative Outcomes: drug consumption

	Adult Population (1)	At Risk Population (2)	Target Population (3)	Adult Population (4)	At Risk Population (5)	Target Population (6)
Panel A: Dependent Variables	***Any Drug***			***Mental-Health Drugs***		
Number of trained GPs/10,000 inhabitants	−0.0154***	−0.0157***	−0.0048	−0.0019	−0.0031	−0.0108*
	(0.004)	(0.004)	(0.006)	(0.002)	(0.003)	(0.006)
Observations	16,728	9656	2679	16,728	9656	2679
R-squared	0.244	0.259	0.093	0.169	0.164	0.163
Panel B: Dependent Variables	***Depression Treatment***			***Sleeping drugs***		
Number of trained GPs/10,000 inhabitants	−0.0018	−0.0024	−0.0100**	−0.0018	−0.0037	−0.0099
	(0.002)	(0.002)	(0.005)	(0.002)	(0.003)	(0.007)
Observations	16,728	9656	2679	16,728	9656	2679
R-squared	0.140	0.140	0.167	0.134	0.130	0.127
Individual Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Labour Market Conditions	Yes	Yes	Yes	Yes	Yes	Yes
Health Status	Yes	Yes	Yes	Yes	Yes	Yes
Lifestyle	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Panel A reports the estimates for any and mental health drugs. Panel B reports the estimates for depression treatment and sleeping drugs, to disentangle effects of these two widely spread treatments. Columns 1 and 4 present the estimates for adult population. Columns 2 and 5 provide the effects of the population at risk; and

columns 3 and 6 for the target population. Individual Characteristics includes age, gender, migrant status and type of household (HH). Labour market conditions contains education, labour market status and income proxies. Health Status controls for chronic conditions (excluding ill-mental health and CVD or diabetes diseases), disability and having limitations in Activities of Daily Living (ADL). Lifestyle incorporates covariates on alcohol consumption, being a smoker and eating at least 5 fruits and vegetables per day. Specifications with time-by-territory fixed effects do not change the results. Time is measured for every survey wave (there are two waves per natural year). Robust standard errors (in parentheses) are clustered at health management area ("Area de Gestió Assistencial, AGA"); there are 43 areas. *** indicates 1% significance, ** 5% and * 10%.

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