

ON CONNECTIONS BETWEEN MENTAL HEALTH AND  
PHYSICAL ACTIVITY AT OLDER AGES

by

Rogier M. Weegink

dr. T.C. Vogt

Faculty of Spatial Sciences

University of Groningen

Groningen, the Netherlands

February 2023

## Table of Contents

Abstract.....	3
Introduction.....	3
Theoretical framework.....	4
Life course and older ages .....	4
Physical activity .....	5
Socio-economic status.....	6
Social interactions.....	7
Methodology.....	8
Data.....	8
Variables .....	9
Methods.....	11
Results.....	12
Correlation between independent variables and CES-D8.....	12
Regression analysis.....	12
Discussion.....	14
Conclusion/s.....	16
References.....	16

## Abstract

This research concerned itself with increasing the understanding between physical activity and mental health at older ages. Using cross-sectional data from the European Social Survey's round 7, sampling over twenty countries with respondents aged 60 and up it was found that physical activity played a significant role in indicating depressive complaints. In the multiple linear regression with CES-D8 score as the outcome variable the other main explanatory variables being socio-economic status and Body Mass Index, similar results were found. Meaning that more physical activity, higher socio-economic status and healthier BMI ranges are related to better mental health for people at older ages in a European context, their respective effects leading to the accumulation of benefits throughout the life-course. It is recommended for future research to include more factors such as environmental determinants and the use of longitudinal data to decipher patterns over a longer amount of time.

## Introduction

Mental health is a key aspect of overall well-being and plays a vital role in an individual's ability to function day-to-day. Over time, more reports have surfaced of declines in mental health. This decline often links to rises in depression and anxiety, with many people experiencing greater levels of stress (Wainberg et al., 2017). Recent shifts such as the pandemic have added to this downward trend (Webb & Chen, 2021). As mental health is mentioned to live inside a complex framework of factors, a closer look will be taken at various physical and social factors, thought to influence mental health. A main factor of this research will be physical activity, which has been proven repeatedly to influence people's mental health (Rebar & Taylor, 2017; Miles, 2007). This is paired with a downward trend in people's exercise regime (Molina, 2018).

The links between physical activity and mental well-being are not to be understated, with evidence that physical activity and happiness promote each other in research both under adolescents and older individuals, marking its importance both in terms of physical and mental health (van Woudenberg et al., 2020; Khazae-Pool et al., 2014). This relation was tested in research using an Iranian sample of people of older age where it was found the group that exercised for eight weeks was significantly happier than the control group (Khazae-Pool et al., 2014). This evidence confirming to the importance of physical activity for mental well-being not only at young ages but at older ages also. With rising life expectancies, it becomes more important to ensure rises in years of healthy life as well, which is bound with physical functions such as motor function and physical fitness (Langhammer et al., 2018)

High depression rates negatively affect society, as people might take lesser care of their health, or can come under extensive financial stress next to having less joyful lives, putting greater stress on other societal systems. Through the decline of mental health societal risks such as poverty, safety and homelessness can pose, these in turn can put pressure on healthcare costs and education quality (TPCHD, 2016). Society has faced such struggles for long, in 1980 M.D. David Burns referred to depression as the number one public health problem, comparing its prevalence to the common cold but with infinitely grimmer consequences. The history goes back much further such as in the biblical tale of King Saul who is assumed to suffer from depression because of post-traumatic stress disorder (Williams & Le Roux, 2012).

The greater underpinnings of mental well-being are not clear-cut and have a plethora of views, some of which discussed here. An existentialist view shaped by Europe's post-WW2 misery (Furman & Bender, 2003) might say humans are forlorn due to being condemned to freedom, rendering a difficult path towards meaning (Furman & Bender, 2003). In the field of cognitive theory, it is stated that people with poorer mental health might have cognitive distortions leading to the amplification of negative behavioural aspects, dichotomous thinking (good and evil) and over-generalizing, such as seeing one failure as an overall theme (Furman & Bender, 2003). A Marxist view of depression might say that because of alienation, depressive complaints are fuelled (Furman & Bender, 2003). Alienation since only increasing due to technological developments like social media (Serpa, 2019), of course in conjunction with Marx's theory that division of labour led to its diminishment from being expressive to an isolated activity (Furman & Bender, 2003).

This research is placed inside the context of the life course approach, which recognizes that certain actions and factors can play out and affect someone over the course of their life (Ben-Shlomo et al., 2002). The approach is often used to study how the presence or absence of key life events shape someone's life trajectories and often focuses on young people as subjects of data (Ben-Shlomo et al., 2002). For this study, it is chosen to look at a sample of older ages, focusing on people of ages 60 and up. This fills a gap by looking at the determinants of mental health in their outcome, rather than from a longitudinal or early life perspective. Some of the indicators tested, such as socio-economic status have already proven to play noteworthy roles regarding the development of children (Gilman, 2002) but are less highlighted in the context of older age. A relation was also found across Europe that saw socio-economic status predict depression symptomatology, with education being the greatest predictor (Freeman et al., 2016).

The aim of this paper is to find out more on the complex nature of mental health and the role of physical activity. To do this a number of social and physical factors are further studied. Leading to the proposal of the following research question: Does physical activity influence the amount of depressive complaints?

To complement the main research question the following sub-questions are formulated:

1. Does socio-economic status predict the level of depressive complaints?
2. Do higher BMI scores indicate the level of depressive complaints?

The paper continues by laying out a theoretical framework. An overview of the life course approach is first given. Additionally, literature and theory are discussed to formulate how physical activity and other variables influence mental health. A conceptual model was designed to complement the research with a visual representation of the most important information. The methodology gives a more in-depth description of the variables of interest while describing the dataset and the specific approach. The results give an overview of what was gathered from statistical tests, which are then summated and contextualized in the discussion and conclusions.

## Theoretical framework

### Life course and older ages

The life course approach is a line of theory that can be used to understand how certain factors and events can manifest throughout an individual's life. There are multiple pathways that can be taken including behavioural, biological, and psychosocial pathways (Ben-Shlomo et al., 2002). These

pathways can be conceptualised through variables and confounding factors of interest, giving insight into how earlier life events and behaviours can shape life trajectories, without denying the influence of adult factors (Ben-Shlomo et al., 2002; Toftager et al., 2011; Novak, 2010). It is assumed that people's lives are ever developing on an individual level through experiences and decisions, the effects of which depend at least on timing in one's life (UBC, 2022).

There are several appendices to the life course theory, one of these is accumulation theory. This dwindle to the fact that certain choices and factors can accumulate in their effect over the life course (Ben-Shlomo et al., 2002). This is sometimes also referred to as a cumulative advantage theory which in this context theorizes that as age increases differences in health increase as well because some will have accumulated benefits but others will not (Kim et al., 2007). In general, when resources and lifestyle from over the life-course influence health in a negative way, they do so increasingly (Pampel & Rogers, 2004), highlighting the need for early life-course intervention (Kivimäki et al., 2020). There also the concepts of sensitive and critical periods. A critical period is a window of time where change in the functioning of an individual is happening more quickly and might be modified more easily in a favourable or unfavourable direction (Ben-Shlomo et al., 2002). A sensitive period is similar but here an exposure has a heightened association on the individual compared to outside of that particular time window (Ben-Shlomo et al., 2002).

Defining old age is done in reference to an earlier paper by (Eldemire-Shearer et al., 2014). In this paper ages 60 and up qualified for the definition of older ages. The age groups could be divided into further cohorts but for the extent of this research, it is chosen not to do so. Age 60 qualified for a 2011 UN summit as being the age where death is no longer seen as premature mortality, becoming an established definition since (Eldemire-Shearer et al., 2014). The research by Eldemire-Shearer also viewed ages 60 and up as being key ages for maintaining independence and preventing disability while doing so (2014). After ages 60 and up, the physical and mental health of people is prone to change as their biological frailty increases and cognitive status decrease, paired with general decreases in physical functioning (Furtado et al., 2018).

## Physical activity

Earlier it was described that mental struggles are an age-old phenomenon, what is even older is the concept of physical activity defined as any action requiring the contraction of skeletal muscles (WHO, 2022) and is often used as an umbrella term for things like sports, leisure activities and physical exercise (Amatriain-Fernández et al., 2020). Physical activity can influence and negate depression, cognitive decline, posttraumatic stress, exhaustion, detachment from others, emotional exhaustion and such, its omission even in short periods hurts both healthy people and people with previous pathologies (Amatriain-Fernández et al., 2020; Rebar & Taylor 2017; Hirvensalo, 2011; CMHA, 2022, Middleton et al., 2010). Physical activity among older adults has been found to boost antidepressant effects (López-Torres Hidalgo, 2019) and their physical activity is suggested to associate with lesser psychological distress (Callow et al., 2020). A 2013 study concluded that adults who are sedentary are twice as likely to exhibit depressive complaints in contrast to their physically active counterparts (De Mello et al., 2013), with both light and strenuous activity found to aid alleviation of mental health symptoms (Callow et al., 2020)

A 2017 paper demonstrates physical activity for people with mental health issues as being largely dependent on contextual factors (such as social support and norms and values), accessibility, certain socio-economic factors, previous partaking in physical activity, emotional well-being and, motivation (Rebar & Taylor). Many recommendations for alleviating mental complaints with the help of physical activity are given as general prescriptions, taking away some form of autonomy, which has been shown to reduce intrinsic motivation, eventually increasing the chance of a return to the baseline with little to none physical exercise (Rebar & Taylor, 2017). For this reason, it is important to be aware that while physical activity in itself is good, having people partake in physical activity that they enjoy is probably better (Rebar & Taylor, 2017).

Adjacent to physical activity is Body Mass Index (BMI) which is used to categorize someone's weight as being under, at or, over a recommended amount (Rauner et al., 2013) General BMI levels have increased for a long time, as well as generally increasing with age, except at stages in later life when a levelling or decline often occurs (Ferraro et al., 2003). BMI has been observed to be higher in people with little physical activity and is also related to mental disorders such as mood disorders and anxiety (Avila et al., 2015) However BMI is not an end-all-be-all measure because of limitations in not accounting for muscle mass, bone density and sex differences (Nordqvist, 2022)

## Socio-economic status

Socio-economic status refers to an individual's position in society based on their education, occupation, and income. Socio-economic status also relays information on social development across the life-course, and is seen as an important predictor of health (Kivimäki et al., 2020). This is explained through two hypotheses, there is the age-as-leveler hypothesis which states that while inequalities might increase across the lifespan they may come together at older ages (Brown et al., 2016). This is related to biological frailty at older ages as well as government support given to the elderly (Kim et al., 2007). This in turn leads to risk factors such as health behaviours and stress to come to similar levels despite (vastly) different life courses. However, education was found to not live within the borders of the aging-as-leveler hypothesis but follow the opposing cumulative advantage theory meaning that education creates a division in physical activity across adults ages based on socio-economic status (Kim et al., 2007). Furthermore, education is seen as the most important predictor of depressive symptomatology within the socio-economic status variable (Freeman et al., 2016). Concluding that people with better education, or in the context of this research better socio-economic statuses, are thought to have an accumulated benefit through life as they stay more physically active (Kim et al., 2007).

In general, lower socio-economic statuses are linked to increases morbidity and disability (Kivimäki et al., 2020). Additionally, it is linked to mental health problems and substance abuse, leading to conditions such as lung cancer, liver disease and dementia (Kivimäki et al., 2020). In this way SES connects to a larger theme were depending on someone's socio-economic status risks of both mental disorders and physical disease (Kivimäki et al., 2020). These findings suggest that addressing mental and physical well-being early on in the life course leads to a reduction of health inequality over time as there is less chance for accumulation of stressors over time (Kivimäki et al., 2020; Furtado et al., 2018). This would place socio-economic status and its benefits under accumulation throughout life hypothesis, consistent with other findings (Kim et al., 2007).

## Social interactions

The Covid-19 pandemic gave lots of opportunities for researchers to study the effects of social isolation and social distancing. One such study looked at the effects of mental health issues in geriatric care. They found that not only the threat of infection but social isolation itself is a potential source of anxiety and other psychological problems (Girdhar et al., 2020). The effects were most felt among the elderly, but disproportionately so among the disadvantaged marginalized (Girdhar et al., 2020). The effects of social isolation pose a heightened risk of cardiovascular and autoimmune diseases (Gerst-Emerson & Jayawardhana, 2015) while social disconnection also increases risks of depression and anxiety (Santini et al., 2020). The lack of social interaction found to lead to fear of abandonment, anxiety about day-to-day activities, and worries about family (Girdhar et al., 2020). This stresses the need for social interactions to be had on a regular basis.

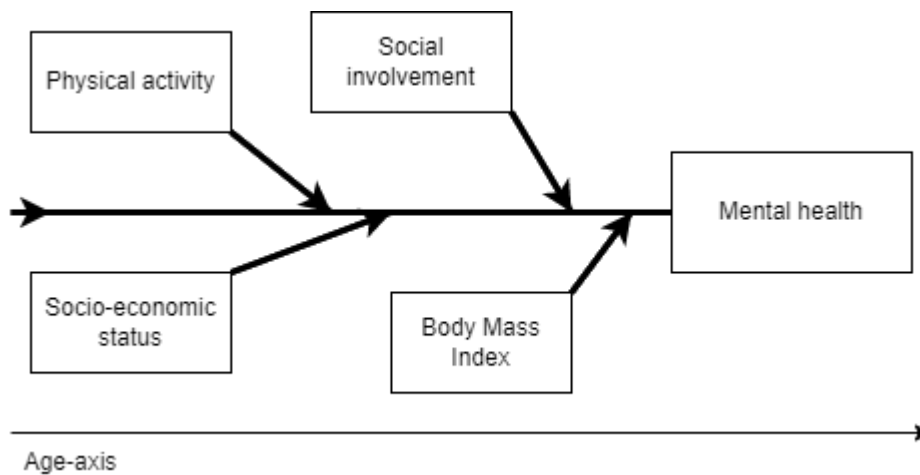


Figure 1 Conceptual model

To complement the research a conceptual model has been shaped. The conceptual model is a visual representation of the assumed relationship between the concepts thought to be relevant to mental health, and their connection to the concept itself. The greyscaled image uses a baseline (coloured black) that connects all variables. Variables are placed across the age-axis showing that over time different variables might become more important. Two important variables (physical activity and socio-economic status) are placed at the start of the model as their effects are thought to accumulate over time. The direction of the model is indicated by the directions of the arrows, all variables are also thought of to be able to positively impact mental health in the right circumstances. The following hypotheses are developed based on the conceptual model:

Hypothesis 1: If respondents are more physically active, they are suffering less from depressive complaints.

Hypothesis 2: If respondents enjoy a higher socio-economic status, they are likely to have fewer depressive complaints.

Hypothesis 3: If respondents have a healthy BMI, they have a higher level of depressive complaints.

## Methodology

### Data

Data used for this research has been previously collected by the European Social Survey. The specific round used was round 7 (2014). The objective of the study is to analyse the relationship between physical activity and mental health at later ages in the European context, but a greater number of determinants are analysed. The European social survey aims to sample representative households within Europe. To meet this requirement all persons aged 15 and above are equally likely to end up sampled. Their nationality, citizenship, or languages spoken are deemed as non-factors based on being included in the survey or not (ESS, 2022).

The European Social Survey provides data in rounds, with rounds being published every two years, and dating back to 2002. The data is cross-sectional, meaning that the collection happens at a single point in time, and does not track change over time. The dataset has a number of core questions focused on social, economic, and demographic factors but also has a rotating module, which for round 7 was Attitudes to immigration and health inequalities. Round 7 of the survey was administered in more than thirty countries (ESS, 2022), 21 of which were used in the analysis.

The method of sampling is a random probability sample. This means that all residents have a chance greater than 0 to be included, while the survey can strictly not use stratified sampling (sometimes referred to as cherry picking). For each of the 21 countries, a minimum sample size of 1500 is sought after, or 800 in countries with a population under two million. Due to the thorough design of the survey and their wide use of face-to-face interviews the quality of their data is up to academic standards. A data quality assessment by ESS criticized the seventh round of underrepresenting some socio-economic groups in the survey (Koch, 2018).

The variables are shown in more detail below. To select relevant cases only for the analysis a filter was written to filter out a significant number of cases. Relevant cases were deemed only those aged 60 and up, to strictly accommodate the older ages relevancy requirement. Furthermore, people had to have statistically valid answers regarding their education, height (cm), weight (kg), gender (1 or 2), doing sports 0-7 times a week, and having answered all CESD-8 questions. There is no mean substitution used in this research. An overview of the descriptives can be found in two separate tables below, table I displays categorical variables and table II shows continuous variables.

*Table I Descriptive overview of categorical variables*

<b>Variable</b>	<b>Categories</b>	<b>n</b>	<b>%</b>
<b>Ever had children living in household?</b>	Yes	8318	82,2
	No	1808	17,8
<b>How often socially meet with friends, relatives or colleagues</b>	Never	270	2,7



	Less than once a month	971	9,6
	Once a month	1052	10,4
	Several times a month	2236	22,1
	Once a week	1854	18,3
	Several times a week	2720	26,9
	Everyday	1016	10,0
<b>BMI category</b>	Underweight	112	1,1
	Normal range	3590	35,5
	Overweight	4302	42,5
	Obese	2115	20,9
<b>Gender</b>	Male	4675	46,2
	Female	5444	53,8
<b>Socio-economic status</b>	Low	2133	21,1
	Mid	6270	62,0
	High	1716	17,0
<b>Do sports or other physical activity, how many of last 7 days</b>	0	3164	31,3
	1	756	7,5
	2	1030	10,2
	3	1064	10,5
	4	735	7,3
	5	651	6,4
	6	327	3,2
	7	2392	23,6

Table II: Descriptive overview of continuous variables

	<b>N</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Mean</b>	<b>Standard Deviation</b>
<b>Depression score (8-32)</b>	10119	8	32	15,3386	2,75604
<b>Age of respondent</b>	10119	60	114	70,83	7,636
<b>Valid N (listwise)</b>	10119				

## Variables

The variables of physical activity, BMI, SES, gender & age are the main independent variables of interest. They are set off against a depression scale that functions as the dependent variable.

### *Depression scale*

To gain insight into the status of the respondent's mental health a modified version of the Centre of Epidemiological Studies' Depression-scale (CES-D) is transformed into a variable that can be utilized as the dependent variable. Questions inquire about depression-related symptoms (Reibling et al., 2014). The original design of the scale uses 20 questions to determine depressive feelings or symptoms in the population (Radloff, 1977). For the purposes of this research, a compacted version that sees less frequent usage is used. There is merit to using the compacted CES-D8 as it has seen use in other research and has been proven effective, specifically by those using the ESS as background data (Klusáček et al., 2022; Van de Velde et al., 2010). The ESS round 7 survey is the most recent survey to have included the eight questions.

The questions asked how often people felt depressed, happy, lonely, enjoyed life, felt sad, could not get going, and felt like everything they did took effort. The questions could then be answered as follows: None or almost none of the time, Some of the time, Most of the time, and All or almost all the time.

For the extent of this research, the answers from the CES-D8 variables will be used in a simple fashion. The corresponding ratings, which are modelled after a Likert scale (1-4) will be summated in a new variable which will range from 8-32. Higher scores will indicate higher severity of depressive complaints, taking after previous research (Klusáček et al., 2022; Van de Velde et al., 2010). This approach leads to a one-dimensional model rather than the two-dimensional model which would include the factors of "depressed affect" and "somatic complaints" loaded onto the depression factor (Klusáček et al., 2022), which is not used because of limitations in time. As there were a small number of cases that did not answer every question, it is opted to not make use of mean substitution analysis. This would have meant that missing values could get filled in by means of replacing the nil value with the arithmetic mean value of the other answered questions.

### *Amount of physical activity*

Physical activity is the lead hypothesized variable of the research. According to the WHO, it includes any movement made by skeletal muscles (2022). For this research physical activity is counted as the number of times one practices sports or other physical activity in the last 7 days for 30 or more minutes at a time. In the European Social Survey, this variable is measured continuously meaning that the score will range from 0 to 7.

### *Socio-Economic Status*

To attribute a socio-economic status to all individual cases a variable was created that ranged from 1 to 3 indicating a low, mid, or high socio-economic status based solely on the level of completed education, the greatest predictor of depression symptomatology (Freeman et al., 2016). Taking after (McNamara et al., 2017) the seven categories of the International Standard Classification of Education (ISCED) were used as the factor to determine socio-economic status. ISCED is an international standard to classify education based on level and direction of the education. It is used by UNESCO and has been standardized since 2011.

A low socioeconomic status is linked to ISCED I & II (lower secondary education), medium (or mid) to ISCED III & IV (upper secondary, post-secondary), and, high to ISCED V (short cycle tertiary and up). Similarly, the reasoning for the grouping is to get an adequate amount of people in each category. Adding a socio-economic variable to the dimension contributes to a widened scope of research. Presumptions about how people with higher socio-economic statuses might enjoy better mental well-being can be checked in this way, and statements about their relationship also add to wider societal relevance of the conclusions.

### *Body Mass Index*

Adjacent to physical health in this research lies the Body Mass Index (BMI). This variable is used to categorize someone's weight as being under, at, or over the recommended amount (Rauner et al., 2013). The index variable is calculated by using 2 bodily measurements from the respondents. The height (cm) and the weight (kg) is plugged into a simple formula:  $\text{weight in kg} / (\text{height in cm})^2 = \text{BMI}$ . The BMI float can tell us something about whether a person can broadly be categorized as underweight, normal weight, overweight or obese based on their mass and height. The relevant categories are described in Table III. The units are  $\text{kg}/\text{m}^2$ . It sees frequent usage as a rule of thumb and is not an end-all-be-all measure

BMI	Weight status
<18,50	Underweight
18.5-24,9	Normal range
25,0-29,9	Overweight
>29,9	Obese or worse

*Table III: BMI category classification*

### *Covariates*

The control variables used in the analysis included age and gender. Furthermore, it is included whether people have had children and how often they meet socially with friends and such. These variables focus on the social end of the spectrum. They are intended to give an indication of people's loneliness and social isolation. In this way, they differ significantly from the main variables of interest. More social interactions are hypothesized to result in lower CES-D8 scores. The children variable provided an indication of the nature and composition of the household and included natural children, foster children et cetera. It is presumable in many cases that children are no longer living inside the house, it can be seen as an indication towards visiting, which are likewise social occasions.

### *Methods*

To find out the relationship between depressive complaints and the independent variables in a meaningful way a Multiple Linear Regression will be conducted. This multivariate regression, will allow for the input of all independent variables at the same time and test them against the dependent variable through a linear function. It allows to test for a relationship between two variables, accounting for the presence of other variables. The test's ability to input more than two variables

make it a more suitable choice than a Simple Linear Regression. It is chosen to not use a logistic regression because the depressive complaint score is assumed to be dynamic and therefore not to be reduced to a categorical variable. Instead, the continuous scale of the Multiple Linear Regression is used to predict the dependent variable by means of the independent variable.

The model will test for a situation where all coefficients equal zero so that it can be known whether the variables add anything to the model at all. It is expected that all coefficients will not equal zero, allowing for the null hypotheses to be rejected. In the situation where the F-scores turn out to be statistically significant, it is assumed that the independent variables accurately predict the dependent variable. The filter applied to the raw dataset refines the cases in the analysis from the original  $N=39964$  back to  $n=10119$ . All these cases are deemed valid and will be included in the final multiple linear regression which is done via SPSS.

To gain some insight into individual variables and the nature of their distributions a set of separate analysis are also conducted. These are mainly more detailed looks at the frequencies of the variables and other statistics, visible above in table I and II. The hypotheses have been conducted prior to the multiple linear regression, to ensure it was valid to make the analysis itself. Lastly, the result host information on the correlation between the CES-D8 and independent variables. This is guided by the Pearson correlation which measures the association between variables by giving a strength and relationship. In this way more can be said about the difference of influence of multiple variables.

## Results

This research aims to find a relationship between the level of physical activity of a respondent and their mental health. Additionally, the study looks at the role of socio-economic status and Body Mass Index's relation to mental health. In this way allowing for interpretation of the dependent variable based on the independent variables described in table I and II. The results start with a correlation analysis, followed by a regression analysis.

### Correlation between independent variables and CES-D8

The strongest correlations that were found using a Pearson correlation formula were for SES and the practice of physical activity. These had a  $-.171$  and  $-1.81$  negative correlation respectively. Furthermore, Age and Gender also had a noteworthy positive correlation of  $.12$  and  $.155$  respectively, lastly, BMI had a smaller positive correlation of  $.075$ . All correlations can be classified as small as they do not exceed  $.3$  (or  $-.3$ ) on the Pearson correlation scale.

### Regression analysis

In table four (IV) an overview of the independent variables is shown with their Standardized Coefficients in relation to the dependent variable. The first row shows the constant, which had an unstandardized B coefficient of  $14,181$ .

**Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	14,181	,336		42,157	,000			
	Ever had children living in household (1 = Yes, 2 = No)	-,111	,068	-,015	-1,617	,106	-,027	-,016	-,015
	How often socially meet with friends, relatives or colleagues	-,167	,017	-,095	-9,947	,000	-,111	-,098	-,094
	BMI (0 = Underweight, 1 = Normal range, 2 = Overweight, 3 = Form of obesity)	,226	,035	,062	6,490	,000	,078	,064	,061
	Gender (1 = Male, 2 = Female)	,799	,053	,145	15,190	,000	,152	,149	,144
	Age of respondent	,027	,004	,076	7,764	,000	,124	,077	,074
	Socio-economic Status (0 = Low, 1 = Mid, 3= High)	-,580	,044	-,129	-13,227	,000	-,172	-,130	-,125
	Do sports or other physical activity, how many of last 7 days	-,127	,010	-,127	-12,978	,000	-,179	-,128	-,123

a. Dependent Variable: Depression score (8-32)

Table IV: Overview of coefficients

The multiple regression ran to make predictions on the severity of depressive complaints and found that amount of physical activity, socio-economic status, BMI, gender, and age were significantly predictors. The measurement of interest did not increase for every single independent variable, as for a number of them they decreased. The respondent's CESD-8 score increased by .062 points for each increase in category of BMI. The CESD-8 score increased by .145 points more for females as opposed to males. CESD-8 also increased with age, by .076 points for each extra year of age. For physical activity, it is calculated that for each day more spent active CESD-8 dropped by .127 points. Socio-economic status led to a .129 drop in CESD-8 score for each increase in category. Finally, having had children living in the house decreased CES-D8 by -.015 while more frequent social meetings led to -.095 decrease. Almost all predictor variables were found to be significant predictors of CESD-8, except for having had children living in the house in any capacity.

The R-squared of this model was measured at .092. Meaning that  $(.092*100) = 9.2\%$  of the variance in the dependent variable can be explained by the independent variables. This would mean that there are many other factors, that likely have more explanatory value regarding the independent variable and gives a nod to the complex nature of mental health. After the analysis, the following is seen as some one's physical activity frequency increases their CES-D8 scores decreases. Higher socio-economic statuses also relate to lower CES-D8 scores. For BMI it was found that higher categories related to higher CES-D8 scores. Both social meetings and having had children living in the house contribute negatively to the CES-D8 score, although having had children was determined too not be statistically significant.

The results of the multiple linear regression allow for hypothesis checking. Regarding hypothesis one it becomes clear at this stage that a higher level of physical activity is negatively related to the participant's CESD-8 score. This means that as people exercise more times a week their depressive complaints decrease. The hypothesis which predicted a similar result based on extensive previous research proving positive linkages between physical activity and mental health was found to be true.

Hypothesis two, which concerned one's socio-economic status and the level of depressive complaints, predicted that higher statuses would lead to a lessened CES-D8 score. This hypothesis turned out to be

correct, a negative relation between the variables was calculated. This means that people in higher socio-economic positions have fewer depressive complaints, as hypothesized. The third hypothesis, which concerned BMI, an important predictor of overweightness was predicted to be higher in cases where people had a lesser degree of depressive complaints. The positive relation between the independent and dependent variable confirms this. This means that the third hypothesis, likewise, is confirmed.

## Discussion

This research looked at the influence of physical activity on mental health in the context of older ages, finding that more physical activity leads to a lower number of depressive complaints. Furthermore, it was found that socio-economic status, and Body Mass Index (BMI) were also found to have significant impacts on depressive symptoms. Higher socio-economic statuses were related to lower depressive complaints while higher BMIs related to worse mental health scores. Additionally, the study found that higher social interaction frequency linked to better mental well-being, while women generally had higher scores on the depressive complaint scale. Lastly, age was found to significantly impact depressive symptoms, with higher age leading to higher scores.

Physical activity has been widely recognized in aiding mental health and its absence can influence mental complaints (Rebar & Taylor, 2017; Hirvensalo, 2011; CMHA, 2002; Amatriain-Fernández et al., 2020). The results show that lower levels of physical activity in older individuals equate to higher CES-D8 scores and the reverse, similar to earlier findings that showed the presence of physical activity leads to greater happiness because of relief in mental complaints, for both adolescents and people of older age (Khazae-Pool et al., 2020; van Woudenberg et al., 2020). Physical activity thus is not only key early in the life-course but also at older ages, giving accumulated benefit to life time practitioners through increases in mental well-being. The frequency of activity is thought to be more important than the intensity (Callow et al., 2020), the importance of frequency was confirmed by findings as CES-D8 continued to decrease as physical activity frequency increased but the data could not provide insight on the role of intensity. Findings by Rebar and Taylor (2017) showed that different people experience different barriers towards physical activity. Despite being difficult to confirm this directly it can be hypothesized that since physical activity is so unequivocally helpful for health, that people who are not physically active experience debilitating barriers. Conversely, people not missing out are less prone to suffer from those barriers (Rebar and Taylor, 2017). Making that lower depressive score link to more physical activity, with long term practitioners holding accumulated benefit, while less likely to face barriers towards regular physical activity.

Socio-economic status is discussed as an indicator of the highest form of education enjoyed, and is contextualized as a relay of information on social development across the life-course. Given that higher socio-economic statuses related to lower CES-D8 scores it seems that having a high-socio-economic status throughout the life-course gives an accumulated benefit. Such as having access to good education, indicating a greater priority towards physical activity which has many positive influences on mental health. Additionally, this also adds to years spent in good health (Langhammer et al., 2018), this on top of evidence on benefits of living through a high socioeconomic childhood (Gilman 2002). The age-as-leveler hypothesis stated that even if health inequality between people diverges during the life-course it converges at older ages due to biological frailty and things like allowances for elderly (Kim et al., 2007). With results indicating increases in age leading to increases in depressive complaints this could have merit. At younger ages other factors could be more important, such as a good education, while at older ages things like government support for elderly

make good health more accessible. Meaning that socio-economic status holds true for accumulation of benefit through life while age possibly is a leveller, drawing a more equitable situation at later stages of life.

In the context of this research BMI was found to predict mental health scores, with healthier BMI scores leading to less depressive complaints. In the framework it was discussed that BMI generally increases throughout life but levels or declines at older ages (Ferraro et al., 2003). This might make it seem that BMI too holds some value in the age-as-leveller concept as BMI eventually gets more equal. Here lies one of the limitations of the variables because it does not account for things like muscle mass and bone density (Nordqvist, 2022), the loss of which could be the leveller for BMI across old age population. This makes it that people with inactive lifestyles could suffer from this source of weight loss, while people with active lifestyles retain these physiological benefits (Nordqvist, 2022). In this way even with BMI getting more levelled with age there still is predominantly an effect of accumulated benefit.

Mental health has had a grip on society for a long time such as seen in old biblical tales and great thinkers such as Marx and Sartre. Research has almost continuously proven the need for physical activity and its relation to health. This has also hold true in this sample of a European population of older age, fitting into a larger theme of the need for physical activity for gains in mental well-being. This, while there can be many barriers to physical activity. Lack of physical activity, and in a similar vein greater depressive complaints also affect other societal systems. Such increased pressure is witnessed through rising poverty and homelessness paired with declines in education quality (TPCHD, 2016). This can lead to a vicious cycle where mobility between socio-economic classes gets impeded by diminishing education quality, rendering a difficult path towards greater mental well-being.

Most predictors had a statistical significance but their combined efforts could not shape a complete picture of mental health. Rather, it shined light on more specific parts. Putting it in line with other studies as more complete picture is being developed. The analysis consisting of around 10.000 cases had an explained variance of under 10%, hinting at the complex nature of mental health. Physical activity was the main focus of this research, with data giving only a ballpark estimate of the true amount of physical activity someone completes due to activity lasting >30 minutes being counted regardless of the total time and intensity. As this data was cross-sectional there was no information on things such as habits of lifetime versus more recent habits. This made it difficult to render a time window for sensitive and critical periods and the possibility of these windows opening up at a later point in the life cycle.

The Centre of Epidemiological studies' depression scale was a returning item of interest and had been reduced from 20 points to 8 points. The longer version including topics such as appetite, self-worth and longing, distributing points from 0-60 which could have added more depth to the research. While also entertaining the possibility of having more distinct classifications in a multi-dimensional model. To test for reverse causality a regression with physical activity as dependent variable was run. This proved CES-D8 to be a significant predictor with a standardized coefficients beta of -.129, making it the largest predictor at that. Despite the inclusion of the BMI variable leading to some insights, its relevance is questionable because it is not inclusionary enough and has 'best case' window for people of ages younger than 60 and up (Nordqvist, 2022).

## Conclusion/s

This research aimed to investigate the influence of physical activity on the mental on people of older ages and found a significant relation between the two. Using a multiple linear regression, a significant relation between depressive complaints and physical activity was established. Therefore, it is important for people to actively partake in physical activity especially from an early age onwards because the benefits of steady physical activity throughout the life-course accumulate. Physical activity can help alleviate mental complaints and physical health issues but might need to be personalized towards the individual to overcome specific barriers to physical activity.

Furthermore, both socio-economic status and BMI were found to also have a significant relationship to the depressive complaints score. Its effects too are theorized to accumulate throughout the life-course. Regarding socio-economic status, education is an important predictor because it predicts not only depressive symptomatology but also education can suffer under mental health complaints. Age can act as a leveler at later phases in the life because of biological frailty and government support for elderly, putting more importance on physical activity and socio-economic status as developing throughout the life course. This research utilized a multiple linear regression and used data from the European Social Survey round 7, doing the analysis with just over 10.000 cases.

## References

- Amatriain-Fernández, S. *et al.* (2020) “Benefits of physical activity and physical exercise in the time of pandemic.,” *Psychological Trauma: Theory, Research, Practice, and Policy*, 12(S1). Available at: <https://doi.org/10.1037/tra0000643>.
- Avila, C. *et al.* (2015) “An overview of links between obesity and Mental Health,” *Current Obesity Reports*, 4(3), pp. 303–310. Available at: <https://doi.org/10.1007/s13679-015-0164-9>.
- Ben-Shlomo, Y. and Kuh, D. (2002) “A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives,” *International Journal of Epidemiology*, 31(2), pp. 285–293. Available at: <https://doi.org/10.1093/ije/31.2.285>.
- Brown, T.H. *et al.* (2016) “Using multiple-hierarchy stratification and life course approaches to understand health inequalities,” *Journal of Health and Social Behavior*, 57(2), pp. 200–222. Available at: <https://doi.org/10.1177/0022146516645165>.
- Burns, D.D. (1980) *Feeling good: The new mood therapy*. New York: Harper.
- Callow, D.D. *et al.* (2020) “The mental health benefits of physical activity in older adults survive the COVID-19 pandemic,” *The American Journal of Geriatric Psychiatry*, 28(10), pp. 1046–1057. Available at: <https://doi.org/10.1016/j.jagp.2020.06.024>.



- De Mello, M.T. *et al.* (2013) "Relationship between physical activity and depression and anxiety symptoms: A population study," *Journal of Affective Disorders*, 149(1-3), pp. 241–246. Available at: <https://doi.org/10.1016/j.jad.2013.01.035>.
- Eldemire-Shearer, D. *et al.* (2014) "Ageing of Jamaica's Population -- What Are the Implications for Healthcare?," *The West Indian medical journal*, 63(1).
- ESS (2022) *European Social Survey, European Social Survey | European Social Survey (ESS)*. Available at: <https://www.europeansocialsurvey.org/> (Accessed: December 14, 2022).
- Ferraro, K.F., Thorpe, R.J. and Wilkinson, J.A. (2003) "The life course of severe obesity: Does childhood overweight matter?," *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 58(2). Available at: <https://doi.org/10.1093/geronb/58.2.s110>.
- Furman, R. and Bender, K. (2003) "The Social Problem of Depression: A Multi-theoretical Analysis," *Journal of Sociology and Social Welfare*, 30(3), pp. 123–138.
- Furtado, G.E. *et al.* (2018) "Physical Frailty and cognitive status over-60 age populations: A systematic review with meta-analysis," *Archives of Gerontology and Geriatrics*, 78, pp. 240–248. Available at: <https://doi.org/10.1016/j.archger.2018.07.004>.
- Freeman, A. *et al.* (2016) "The role of socio-economic status in depression: Results from the Courage (Aging Survey in Europe)," *BMC Public Health*, 16(1). Available at: <https://doi.org/10.1186/s12889-016-3638-0>.
- Geifman, N., Cohen, R. and Rubin, E. (2013) "Redefining meaningful age groups in the context of disease," *AGE*, 35(6), pp. 2357–2366. Available at: <https://doi.org/10.1007/s11357-013-9510-6>.
- Gerst-Emerson, K. and Jayawardhana, J. (2015) "Loneliness as a public health issue: The impact of loneliness on health care utilization among older adults," *American Journal of Public Health*, 105(5), pp. 1013–1019. Available at: <https://doi.org/10.2105/ajph.2014.302427>.
- Gilman, S.E. (2002) "Commentary: Childhood socioeconomic status, life course pathways and Adult Mental Health," *International Journal of Epidemiology*, 31(2), pp. 403–404. Available at: <https://doi.org/10.1093/ije/31.2.403>.
- Girdhar, R., Srivastava, V. and Sethi, S. (2020) "Managing mental health issues among elderly during COVID-19 pandemic," *Journal of Geriatric Care and Research*, 7(1), pp. 32–35.

- Hirvensalo, M. and Lintunen, T. (2011) “Life-course perspective for physical activity and sports participation,” *European Review of Aging and Physical Activity*, 8(1), pp. 13–22. Available at: <https://doi.org/10.1007/s11556-010-0076-3>.
- Khazaei-pool, M. *et al.* (2014) “Effects of physical exercise programme on Happiness Among Older People,” *Journal of Psychiatric and Mental Health Nursing*, 22(1), pp. 47–57. Available at: <https://doi.org/10.1111/jpm.12168>.
- Kim, J. and Durden, E. (2007) “Socioeconomic status and age trajectories of health,” *Social Science & Medicine*, 65(12), pp. 2489–2502. Available at: <https://doi.org/10.1016/j.socscimed.2007.07.022>.
- Kivimäki, M. *et al.* (2020) “Association between socioeconomic status and the development of mental and physical health conditions in adulthood: A multi-cohort study,” *The Lancet Public Health*, 5(3). Available at: [https://doi.org/10.1016/s2468-2667\(19\)30248-8](https://doi.org/10.1016/s2468-2667(19)30248-8).
- Klusáček, J., Kudrnáčová, M. and Soukup, P. (2022) “Validation of CES-D8 among Czech university students during COVID-19 pandemic,” *Ceskoslovenska psychologie*, 66(4), pp. 398–415. Available at: <https://doi.org/10.51561/cspsych.66.4.398>.
- Koch, A. (2018) *Assessment of socio-demographic sample composition in ESS Round 7*. rep. GESIS Leibniz Institute for the Social Sciences.
- Langhammer, B., Bergland, A. and Rydwick, E. (2018) “The importance of physical activity exercise among older people,” *BioMed Research International*, 2018, pp. 1–3. Available at: <https://doi.org/10.1155/2018/7856823>.
- López-Torres Hidalgo, J. (2019) “Effectiveness of physical exercise in the treatment of depression in older adults as an alternative to antidepressant drugs in primary care,” *BMC Psychiatry*, 19(1). Available at: <https://doi.org/10.1186/s12888-018-1982-6>.
- McNamara, C. *et al.* (2017) *The socioeconomic distribution of non-communicable diseases in Europe: findings from the European Social Survey (2014) special module on the social determinants of health*. European Journal of Public Health.
- Middleton, L.E. *et al.* (2010) “Physical Activity Over the Life Course and Its Association with Cognitive Performance and Impairment in Old Age,” *Journal of the American Geriatrics Society*, 58(7), pp. 1322–1326. Available at: <https://doi.org/10.1111/j.1532-5415.2010.02903.x>.

- Miles, L. (2007) "Physical activity and health," *Nutrition bulletin*, 32(4).
- Molina, B. (2018) *1.4 billion people aren't exercising, who reveals. here's why that's a big problem*, USA Today. Gannett Satellite Information Network. Available at: <https://eu.usatoday.com/story/news/nation-now/2018/09/05/adults-worldwide-not-exercising-study-who/1199978002/> (Accessed: January 27, 2023).
- Nordqvist, C. (2022) *Why BMI is inaccurate and misleading*, *Medical News Today*.
- Novak, M. (2010) "Social inequity in health," *The National Graduate School of Gender Studies*. [Preprint].
- Pampel, F.C. and Rogers, R.G. (2004) "Socioeconomic status, smoking, and Health: A Test of competing theories of cumulative advantage," *Journal of Health and Social Behavior*, 45(3), pp. 306–321. Available at: <https://doi.org/10.1177/002214650404500305>.
- Radloff, L.S. (1977) "The CES-D Scale," *Applied Psychological Measurement*, 1(3), pp. 385–401. Available at: <https://doi.org/10.1177/014662167700100306>.
- Rauner, A., Mess, F. and Woll, A. (2013) "The relationship between physical activity, physical fitness and overweight in adolescents: a systematic review of studies published in or after 2000," *BMC Pediatrics*, 13(1). Available at: <https://doi.org/10.1186/1471-2431-13-19>.
- Rebar, A.L. and Taylor, A. (2017) "Physical activity and mental health; it is more than just a prescription," *Mental Health and Physical Activity*, 13, pp. 77–82. Available at: <https://doi.org/10.1016/j.mhpa.2017.10.004>.
- Reibling, N. *et al.* (2017) "Depressed during the depression: has the economic crisis affected mental health inequalities in Europe? Findings from the European Social Survey (2014) special module on the determinants of health," *European Journal of Public Health*, 27(suppl\_1), pp. 47–54. Available at: <https://doi.org/10.1093/eurpub/ckw225>.
- Santini, Z.I. *et al.* (2020) "Social disconnectedness, perceived isolation, and symptoms of depression and anxiety among older Americans (NSHAP): A longitudinal mediation analysis," *The Lancet Public Health*, 5(1). Available at: [https://doi.org/10.1016/s2468-2667\(19\)30230-0](https://doi.org/10.1016/s2468-2667(19)30230-0).
- Serpa, S. (2019) "Alienation on social media," *Studies in Media and Communication*, 7(1), p. 17. Available at: <https://doi.org/10.11114/smc.v7i1.4286>.

Tacoma-Pierce County Health Department (2016) “Unattended Mental Health’s Impact on Society.”

Tacoma: Washington, United States.

Toftager, M. *et al.* (2011) “Distance to Green Space and Physical Activity: A Danish National Representative Survey,” *Journal of Physical Activity and Health*, 8(6), pp. 741–749.

Available at: <https://doi.org/10.1123/jpah.8.6.741>.

University of British Columbia (2022) *Life Course Theory - University of British Columbia Wiki*,

*Wiki.ubc.ca*. Available at:

[https://wiki.ubc.ca/Life\\_Course\\_Theory#:~:text=Examples%20include%3A%20an%20individual%20who,to%20his%20Fher%20age%20group](https://wiki.ubc.ca/Life_Course_Theory#:~:text=Examples%20include%3A%20an%20individual%20who,to%20his%20Fher%20age%20group). (Accessed: 2022).

Van de Velde, S. *et al.* (2010) “Gender differences in depression in 25 European countries after

eliminating measurement bias in the CES-D 8,” *Social Science Research*, 39(3), pp. 396–404.

Available at: <https://doi.org/10.1016/j.ssresearch.2010.01.002>.

van Woudenberg, T.J. *et al.* (2020) “The reciprocal effects of physical activity and happiness in adolescents,” *International Journal of Behavioral Nutrition and Physical Activity*, 17(1). Available at: <https://doi.org/10.1186/s12966-020-01058-8>.

Wainberg, M.L. *et al.* (2017) “Challenges and opportunities in Global Mental Health: A research-to-practice perspective,” *Current Psychiatry Reports*, 19(5). Available at: <https://doi.org/10.1007/s11920-017-0780-z>.

Webb, L.M. and Chen, C.Y. (2021) “The COVID-19 pandemic's impact on older adults' mental health: Contributing factors, coping strategies, and opportunities for improvement,”

*International Journal of Geriatric Psychiatry*, 37(1). Available at:

<https://doi.org/10.1002/gps.5647>.

Williams, G. and Le Roux, M. (2012) “King Saul's mysterious malady: original research,” *HTS: Theological Studies*, 68(1).

World Health Organization (2022) *Physical activity, Who.int*. Available at:

<https://www.who.int/news-room/fact-sheets/detail/physical-activity> (Accessed: 2022).

