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A Study on the Relationship between Income and Health among Norwegian Adults

Master's thesis in Social Welfare and Health Policy

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Abstract

This study analyses the relationship between income and health among Norwegian adults aged 40-67 years. Its main aim is to assess the effect of individual differences in income on their health status and to better understand the association between income and health. It used data from the Norwegian Life Course, Ageing and Generation Study (NorLAG) conducted in 2002. Data were collected through computerized telephone interviews (CATI) and self-administered postal questionnaires. A total of 4183 sampled respondents aged 40-67 years were selected using a multistage sampling technique. Univariate, bivariate, and multivariate statistical analyses were performed. The results of this study show that there is a statistically significant direct association between income and health. However, income was found to have a weak positive correlation with health and a small effect on changes in health status. The results also show that differences in the other socioeconomic status variables such as education, age and gender can influence health status. Higher education was found to be associated with better health and lower education with poor health. Older adults are associated with poorer health, while the opposite is true for younger adults. Regarding gender, adult men are associated with relatively better health than their counterparts. Education is weakly positively correlated with health, while age and gender are weakly negatively correlated. In addition, the results of multiple regression analysis showed that income and other socioeconomic status variables together explained less than 10% of the variation in health. Income and education account for two-thirds (the majority) of all variations in health status, while age and gender account for the rest. Income alone accounts for only less than 3% of the variation in health status. Based on these results, I conclude that income and health are weakly positively related among Norwegian adults, and that income has little effect on variability in health. Contrary to expectations, income is not the strongest predictor of variation in health status, but education is.

Key words: Age, Adult, Education, Gender, Health, Income, Norway

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1. Introduction

1.1. Background

In 1946, the World Health Organization proposed good health and health equity among the people as a strategic goal for all member states (WHO, 1946). Thus, the Norwegian government has always pursued strategic health goals through the Universal Health and Social Insurance coverage system. Of course, this may be due to the fact that Norway's form of government is welfare, a generous system of social benefits (Koipysheva, 2018). Therefore, Norway is considered one of the best countries to live in, with high health indicators (Hansen et al., 2012).

Knowledge obtained through empirical research is often considered the most important decision-making tool for achieving strategic health goals and implementing health policies. Research conducted to understand the factors affecting health is one of the most important in this regard. Income, as an important indicator of socioeconomic status variables, has received much research attention because it plays a dominant role in influencing people's health status (Preston, 1975; Mackenbach et al, 1997; Li and Zhu, 2006).

There is a growing body of research showing the relationship between income and health (Adeline and Delattre, 2017; Fiscella and Franks, 2000). Most research show that higher income is associated with better health, while the opposite is true for lower income. Researchers argue that this is because income facilitates access to health services, better housing and sanitation, and adequate nutrition, leading to improved health outcomes, or vice versa (Freeman et al., 2016; Marmot and Wilkinson, 2001).

However, in writing this article-based thesis on the relationship between income and health, an initiative was taken to fill a gap in previous research. In other words, most previous studies have used three measures of health outcomes to analyse the relationship between income and health. These include self-reported health status, life expectancy and mortality. However, there is a lack of studies that have used norm-based standardized health outcome measures to analysis the relationship between income and health. But I use a new measure of health outcomes to analyse the relationship between income and health. The new health outcome measure used here is the

SF-12 physical health, a standardized universal norm-based measure of health-related physical functioning and general health-related quality of life (Ware et al., 1995).

In addition, in the Nordic welfare system, governments have the strategy to redistribute income among the population through large tax policies, influencing income impacts and ensuring equal access to health services (Katikireddi, 2019). However, previous studies examining this relationship were neither typical nor specific to Nordic welfare systems, nor did they focus on the adult age group of the Norwegian population in question. Furthermore, income can influence health status interaction with other socioeconomic status variables such as, education, age and gender. Of course, there are studies that show health disparities due to the individual influence of these socioeconomic status variables. However, adequate research is still lacking, but in this study I show how the combination of these socioeconomic status variables affects the health status of the population in question (Link and Phelan, 1995; and Bottorff, J.L., 2011).

In light of the above, this study sought to fill a research gap by examining the relationship between income and health among Norwegian adults aged 40-67 using the NorLAG dataset. To achieve this goal, I seek answers to the following research questions: Is there a relationship between income and health status of Norwegian adults aged 40-67? Is there a relationship between educational level, age and gender of Norwegian adults and their health status? Does income inequality affect the health status of Norwegian adults aged 40-67? Do education, age and gender differences affect the health status of Norwegian adults aged 40-67? How much does income affect changes in health status alone and together with education, age and gender?

As stated in the theoretical framework section of this study, there are three main approaches for studying the systemic relationship between income and health. These include the absolute income hypothesis, the relative income hypothesis, and the income inequality hypothesis (Markus, 2015; Wagstaff, 2003; Preston, 1975). However, due to the type of available data and the research interest, my empirical study is based on the concept of the absolute income hypothesis to answer the above research questions. Therefore, I formulate my first alternative hypothesis as follows:

First Alternate Hypothesis ***(H_1)***: the health status of the high income population is significantly different from the health status of the low income population.

In addition, I hypothesize that the relationship between income and health should be further developed, taking into account the influence of other socio-economic variables. In other words, other important socioeconomic status variables such as education, age and gender, may also significantly influence the relationship. However, I believe that income can play a greater role in explaining the relationship when combined with other socioeconomic status variables. Therefore, I formulate the remaining four alternative hypotheses as follows:

Second Alternate Hypothesis (H_2): the health status of the population with high education level is significantly different from the health status of the population with low education level.

Third Alternate Hypothesis (H_3): the health status of the older adult population is significantly different from the health status of the younger adult population.

Fourth Alternate Hypothesis (H_4): the health status of the female population is significantly different from the health status of the male population.

Fifth Alternate Hypothesis (H_5): comparing the combined interactive effects of income, age, gender, and education, income is the strongest predictor of variations in health status.

1.2. Article Submission

This article-based master's thesis was written for publication in Health Economics, a section of the journal Frontiers in Public Health. Frontiers published well-established peer-reviewed articles. Frontiers in Public Health have an impact factor of 6.461 and a citeScore of 4.0. It is indexed in the Norwegian Centre for Research Data (NSD). The journal is also a partner of OsloMet.

2. Literature Review

2.1. Previous Studies

A growing number of studies are investigating the relationship between income and health. Many of these studies support the hypothesis that income is strongly related to health (Adeline and Delattre, 2017; Mackenbach et al., 1997; Marmotetal, 1991; Blackburn, 1994; Chandola, 1998; Preston, 1975; Rodgers, 1979).

During the middle of the 1970s, studies were performed by Fuchs (1974) and Preston (1976) to understand whether the national economy could critically determine population health in industrialized countries. The results of the study have shown that at a certain level of socioeconomic development, additional increases in national income had little effect on increasing national life expectancy (Macinko et al., 2001; Fuchs 1974; Preston 1976). Evidently, the results of these studies were consistent with Omran's epidemiological transition theory that stated that as nations transform to higher levels of economic development, two things are likely to happen. The first is that the cause of human deaths will shift from infectious to chronic, which is called an epidemiological transition. The second is that life expectancy will increase, and the burden of mortality will become significantly composed of old people rather than very young people, which is said to be a demographic transition (Omran, 1971).

Although the majority of early studies have shown the effect of income on population health outcomes, it was in the late 1970s that studies began to be specific to publications that observed the associations of income and health across various social and economic groups within and across the country (Black et al. 1980). When Wilkson (1996) postulated the income inequality hypothesis, the main determinant of differences in health outcomes among developed countries is the magnitude of differences in the disparity between the incomes of the rich and the poor within countries instead of differences in income levels. That is, better health status appears to be positively correlated not only with higher levels of income but, in most cases, even more strongly associated with the equitable distribution of income among the population in a country.

A study that aimed to understand the relationship between income and self-assessed health status using a cross-sectional survey of the British population found that income is significantly associated with health status and appears to be a better predictor of health status than other socioeconomic measures, such as education or occupation (Benzeval et al., 2001).

A recent study of the relationship between income and health in seven European countries, including Belgium, Denmark, England, Finland, France, the Netherlands and Norway, in males and females aged 25 and over, found that people with high incomes are associated with better self-assessed health status in all countries (Mackenbach et al., 2005).

Similarly, a more recent study that examined the health effects of income inequality in developing Asian economies from 1991 to 2019 found that income inequality negatively affects life expectancy. Higher income inequality has a negative effect on health, while less income inequality has a positive effect on health (Chang and Gao, 2021).

Coming to the Norwegian case, a study of whether relative income was associated with individual mortality in Norway between 1994 and 1999 found that low relative income increased the risk of mortality for people with average or lower absolute income when relative income was calculated based on average income in medium-sized or larger populated regions (Elsta et al., 2006). Likewise, a comparative study of life expectancy differences between Norway and the United States showed that Norway had significant and increasing differences in life expectancy by income level between 2005 and 2015 compared to the United States, especially among the lower and middle income groups (Kinge et al., 2019).

Finally, looking at how other socioeconomic status variables, in interaction with income, can affect health status, a study of socioeconomic inequalities in health conducted in 22 European countries found that those with lower education had higher mortality rates than those with higher education (Mackenbach et al., 2008). It is argued that the higher the level of education, the higher the chances of getting a high-paying job. Education thus generates income that improves the health of its beneficiaries (Link and Phelan, 1995). Income differences between younger and older adult age groups are also greater. This is because incomes may decrease for older generations who may be less physically able to work (Link and Phelan, 1995). And research also shows that gender affects people's health. Although various findings showed that women lived longer than men, some studies showed that women have poorer self-rated health response than men. Thus, findings show conflicting results about gender differences in health (Bottorff, J.L., 2011; Warraich and Califf, 2019; Akhtar et al., 2023).

2.2. Theoretical Framework

Several studies have shown a relationship between income and health using different approaches. Most studies have attempted to examine the relationship between income and health in three different but related ways. In this way, three main hypotheses seem to have been developed to examine the relationship between income and health. They are absolute income hypothesis, the income inequality hypothesis, and the relative income hypothesis.

Absolute income hypothesis: the absolute income hypothesis was established to show how an individual's absolute level of income can impact his or her health. Preston (1975) argues that there is a positive and concave association between absolute income (income after tax in a year) and health. This hypothesis argues that higher incomes have better health outcomes, as they can lend a hand to afford the means for purchasing goods and services that have a relationship with health. However, according to this hypothesis, income inequality and relative income have no direct impact on health. Likewise, Rodgers (1979) argued that the relationship between income and health is concave, that is, each additional amount of an individual's income improves an individual's health status, but by ever smaller amounts. In addition, authors such as Mackenbach et al. (2005) and Carrieri and Jones (2017) also demonstrate a positive association as well as a nonlinear relationship between income and health in their respective studies.

Income inequality hypothesis: the income inequality hypothesis claims that individual health status is affected not only by its own level of income but also by the magnitude of income inequality within the population in the area where they live (Mellor and Milyo, 2002; Ettner SL, 1996; Wagstaff, 2003; Van Doorslaer, 2004). Thus, the level of income inequality within the population equivalently determines the health of both rich and poor individuals, which can be considered a public bad, as income inequality within a population is a threat to the health status of every individual (Adeline and Delattre, 2017).

Different authors have identified three potential pathways by which income inequality may affect health status. The first is the structural pathways argument that states that high income inequality results in settlement isolation of the poor (low well-off), and residential segregation possibly affects individual health (Wen, Browning, and Cagney, 2003). The second is based on the argument that individual health is affected by social relations and social cohesion. This indicates that income inequality affects health by diminishing social cohesion and deteriorating the formation of social capital useful to health (Kawachi et al. 1997). The third argument is linked to policy and strategic pathways that claim that income inequality could impact health status because of the discrepancy between rich and poor individuals influencing the implementation of certain health-related policies (Neckerman and Torche 2007).

Relative income hypothesis: the relative income hypothesis states that health is affected by not only the absolute income level but also by the relative income ranking of individuals in the income distribution hierarchy. Simply put, health deteriorates when income decreases relative to others, and health improves when income increases relative to others. That means that relative income directly affects health outcomes (Hildebrand and Van Kerm, 2009; Cohen, et al., 1997). In this regard, studies show that the attitude of relative disadvantage, whether financial or non-financial, can cause stress and depression in people, which directly or indirectly threatens their health. In other words, relatively well-off people have the financial means to access goods and services that help avoid health risks and vice versa (Markus, 2015; Li and Zhu, 2006).

To sum, while most previous literature points to income inequality and relative income as the main causes of health inequality, my results suggest that absolute income may be a descriptor of health, albeit weakly positively correlated. Thus, my research adds to the literature that argues that absolute income is an important predictor of health.

3. Data and Methods

3.1. Ethics and Data Source

I used data from the Norwegian Life Course, Ageing and Generation Study (NorLAG) to examine the relationship between income and health status among Norwegian adults aged 40–67. NorLAG is administered by the Norwegian Institute for Social Research (NOVA). Statistics Norway, the National Statistical Institute of Norway, in collaboration with NOVA, was responsible for sampling and data collection (Veenstra et al., 2021). Therefore, this article-based thesis has been prepared in accordance with Statistics Norway's rules on the use of statistical results and analyses, including in research.

3.1. Sample Selection

Three waves of the NorLAG survey have been conducted so far (2002, 2007, and 2017) using computer-assisted telephone interviews (CATI) and self-administered postal questionnaires linked to national registry data. I use data from the first wave conducted in 2002. The sampled respondents were 40 to 80 years old and lived in 24 municipalities and six townships across Norway (Veenstra et al., 2021). The full sample of the first wave includes 9057 respondents, for a response rate of 78%.

However, for analysis, I identified a subsample of 4222 individuals (n=4222), which consists of respondents aged 40-67 in 2002 whose annual income was above zero Norwegian Krone (NOK). The upper age limit was chosen because the normal retirement age in Norway is 67. An income level above zero NOK was chosen because my aim was to study people with a certain income level.

In addition, missing values, such as values for missing respondents, as well as negative values, such as negative income values, were excluded before other statistical operations. I noticed that a total of 39 missing values were recorded. Then, I excluded respondents with missing values for all variables included in the analysis. Therefore, in the end, I am ultimately left with a subsample of 4183 individuals in the analysis.

3.3. Dependent and Independent Variables

Five variables were used in the study to conduct the analysis. The variables used in the study are SF-12 norm-based standardized physical health (hereinafter referred to as SF-12 physical health), income after tax, education, age, and gender. I have divided these variables into two broad groups: dependent and independent variables. The SF-12 physical health is the dependent variable, while income after tax, education, age, and gender are the independent variables.

SF-12 physical health is a standardized norm-referenced measure of health outcome on individual’s life. It is often used as a measure of quality of life. The SF-12 is a shortened version of the SF-36, which itself evolved from the Medical Outcomes Study. In other words, the SF-12 was developed as a short alternative form of the SF-36 and was created to reduce the burden of response.

The SF-12 is a subset of 12 items covering the same eight health outcome domains of the SF-36 Health Survey (SF-36) (Ware & Sherbourne, 1992; Ware et al., 1993). This includes limitations in physical activities because of health problems (physical functioning), limitations in usual role activities because of physical health problems (role-physical), bodily pain, general health perceptions, vitality (energy and fatigue), social functioning, limitations in usual role activities because of emotional problems (role-emotional), and general mental health (psychological distress and well-being).

SF-12 physical health is a continuous variable scored using norm-based methods. SF-12 physical health scores range from 0 to 100, with higher scores indicating better physical health conditions, while the reverse is true for lower scores (Ware et al., 1995). In general, the SF-12 provides norm-referenced scores. Norm-based scoring linearly transforms scales and summary measures so that they have a mean of 50 and a standard deviation of 10. Because each scale has a standard deviation level of 10, it is easier to see exactly how much below or above the general population mean scores are in standard deviation units, and the health domain scale and summary measurement point comparisons can be made directly (Turner-Bowker and Hogue, 2014).

Annual income after tax is the main independent variable used in the analysis. Income after tax is a continuous variable. As stated above, an annual income level above zero NOK was chosen because the purpose of the study was to examine people with a certain income level.

Education is another variable used in the analysis. Education level is an ordinal categorical variable with eight categories (0 = no education and preschool education, 1 = primary education, 2 = junior education, 3 = upper secondary, basic education, 4 = upper secondary, final education, 5 = postsecondary education, 6 = university and college education, lower level, 7 = university and college education, higher level, and 8 = PhD). I believe that education is classified in detail in the existing dataset, and I decided to re-categorize it to make it more general and simplify the analysis. Therefore, to simplify the analysis, I coded education into three new categories:

1=primary (lower) education level, 2=secondary (middle) education level and 3=tertiary (higher) education level. The primary (lower) education level includes no education and preschool education, primary education, and junior education. The secondary (middle) education level includes upper secondary basic education, upper secondary final education, and postsecondary education. The tertiary (higher) education level includes university and college education lower level, university and college education higher level, and PhD. Again, education is not a metric variable, so I cannot include it in the regression equation. Therefore, I need to create dummy variables for education. Thus, I created a dummy variable for education (0=low and 1=high) for the regression analysis. Low education includes both primary and secondary levels of education, while high education includes higher levels of education in the former category.

Age is another independent variable used in the analysis. Age is a continuous variable. The study used adult respondents whose ages ranged from 40-67 in 2002. As mentioned earlier, the upper age limit was chosen because the normal retirement age in Norway is 67.

Gender is another independent variable used in the analysis. In the data, gender is recorded as a nominal dichotomous categorical variable (1 = male and 2 = female). Because gender is not a numerical variable, it cannot be included in the regression equation. Therefore, I created a gender dummy variable (male is coded 0 and female is coded 1) for the regression analysis.

3.4. Method of data analysis

Before analysing the date, a data inspection was done to check whether the data distribution of the dependent variable was normal or not. Histogram, skewness and kurtosis were used for this purpose. Although there are significant values outside the normal curve, the skewness and kurtosis values indicated that the distribution of the data is within the normal range.

Univariate, bivariate and multivariate regression analyses were performed using descriptive and inferential statistical techniques to analysis the data. Univariate analyses were performed to obtain basic information about the variables in the dataset. Univariate analyses were performed using descriptive statistics. Descriptive statistics used for the univariate analyses include range, standard deviation, mean, median, mode, and frequencies.

Bivariate correlation analysis was performed to measure the strength of the linear relationship between the dependent and independent variables and to compute their association. Pearson's correlation was used to measure the linear relationship between two continuous and continuous/categorical variables, while Spearman's correlation was used to measure the linear relationship between two categorical variables. When determining the correlation between the dependent and independent variables, the strength of the association was determined by p-values, while the correlation coefficient (r) values were used to measure the strength and direction of the linear relationship between two variables.

With this in mind, the study expanded the bivariate associations of each independent variable with the dependent variable, such as SF-12 physical health by income, SF-12 physical health by education level, SF-12 physical health by age, and SF-12 physical health by gender.

This study extended the analysis beyond bivariate and performed a stepwise multivariate linear regression analysis. Multiple linear regression analysis was performed to investigate the relationship between the dependent and independent variables and to model the relationship between these variables. Therefore, four models were developed for the regression analysis with the SF-12 physical health as outcome variable controlling for income (Model 1); income and education (Model 2); income, education and age (Model 3); and income, education, age and gender (Model 4) to make predictions about what the dependent variable will do based on the scores of the independent variables. The model is represented by the following equation:

$$y=\beta_0+\beta_1 x_{i1}+\beta_2 x_{i2}+\ldots+\beta_p x_{ip}+\epsilon$$

Where, for $i=n$ observations:

y = dependent variable, that is, SF-12 physical health

xi = explanatory variables such as income after tax, education level, age and gender.

β_0 = y-intercept (constant term), that is, the value of SF-12 physical health where the values of income after tax, education level, age and gender and the error term are zero.

βp = slopes or coefficients for each explanatory variable such as income after tax, education level, age and gender.

ϵ=the model's error term (also known as the residuals)

I used the program SPSS 27 - Statistical Package for Social Sciences to analyse the statistical data. The analysis was run stepwise to see the change in health in each model. Using SPSS, I calculated the coefficient of determination R^2 to estimate what percentage of the total variance in SF-12 physical health is explained stepwise by income, education, age, and gender. In other words, the adjusted R-squared was used to measure how much of the variance in health is accounted for by income alone in Model 1; by income and education in Model 2; by income, education and age in Model 3; and by income, education, age and gender in Model 4. Then, I report p-values to measure the significance of the associations, unstandardized beta coefficients (B) to estimate the effect of each unit of the independent variable on the dependent variable, and standardized beta coefficients (Beta) to measure the strength of the associations between the dependent and independent variables.

4. Results

4.1. Univariate Analysis

Univariate analysis was performed to examine each variable independently. It sought to look at the central tendency and dispersion of values, as well as the response patters of each variable. Table 1 describes the characteristics of the data set, summarizing the data samples by gender, age, marital status, educational level, income after tax, and SF-12 physical health.

Table 1. Descriptive Statistics

Variables	Categories	SD	Range	Mean	Median	Mode	Freq.	%
Physical health		10.77	54.33	48.15	53.13	56.58	4183	100
Income after tax		90149	396000	230514	210000	200000	4183	100
Education Level		0.71	2	2.1	2	2	4183	100
	Primary						951	22.7
	Secondary						2036	48.7
	Tertiary						1196	28.6
Age		7.40	27	53.1	53	50	4183	100
Gender		0.5	1	1.5	2	2	4183	100
	Male						2031	48.6
	Female						2152	51.4

As shown in Table 1, a total of 4183 samples were selected for the study. The respondents were both men and women. There were slightly more women (51.4%) than men (48.6%). The age of the respondents ranged from 40 to 67 years. The mean, median and mode are used to describe the centrality of the respondents' ages. The average age of the respondents was 53 years. The median age was 53 years, which is the middle score of the adult respondents after it has been arranged in order of magnitude. Fifty years old was the most frequently recorded age in the sampled population, as the mode value was found to be 50.

With regard to education, frequencies are used to define the description. The samples were described according to their educational level. Of all respondents, 48.7% (2036) had secondary (middle) education, 22.7% (951) had primary (lower) education and 28.6% (1196) had tertiary (higher) education.

As far as annual income after tax is concerned, mean, median and mode can be used to describe the centrality of respondents' income. The average income was NOK 230514.00, the middle income was NOK 210000.00, and the most frequently recorded income was NOK 200000.00. The dispersion of respondents' incomes is estimated using the range and standard deviation. Thus, the range was found to be NOK 396000 while that of the standard deviations was 90149.

With respect to centrality of respondents' SF-12 physical health, the mean can be used to quantitatively describe the SF-12 physical health score. The mean SF-12 physical health score was calculated to be 48.15, which is closer to the standardized SF-12 physical health mean. According to Ware et al. (1995), SF-12 physical health has a mean value of 50, which is an average physical health status. With regards to dispersion of respondents' SF-12 physical health, the standard deviation can be used to show how it is dispersed in relation to the mean. The standard deviation of the SF-12 physical health score was calculated to be 10.77.

4.2. Bivariate Analysis

This section presents the results of the bivariate correlation analysis of the dependent and independent variables. When dealing with correlation, it was important to take two steps. First, the strength of the significant association between the dependent and independent variables was determined. The strength of the significant associations between dependent and independent variables is determined by p-values. As shown in Table 2, the calculated p-value was found to be < 0.001 for all variables.

Second, the correlation coefficient was calculated to measure the strength and direction of the relationship between the dependent and independent variables. In this analysis, the dependent variable (SF-12 physical health) was correlated with each independent variable. As shown in Table 2, a weak positive correlation coefficient of r = 0.17 emerged for the relationship between income after tax and SF-12 physical health. The correlation between education level and SF-12 physical health appeared to be 0.20. The correlation between age and SF-12 physical health was found to be -0.18. And the correlation coefficient between SF-12 physical and gender was calculated as -0.10. Generally, a p-value less than or equal to 0.05 indicates a significant association between variables.

Table 2. Associations of dependent variable with independent variables

		SF-12 physical health
Income after tax	Pearson Correlation	.17**
	Sig. (2-tailed)	.000
	N	4183
Education	Pearson Correlation	.20**
	Sig. (2-tailed)	.000
	N	4183
Age	Spearman's rho	-.18**
	Sig. (2-tailed)	.000
	N	4183
Gender	Spearman's rho	-.10**
	Sig. (2-tailed)	.000
	N	4183

**Correlation is significant at the 0.01 level (2-tailed).

4.3. Multivariate Regression Analysis

This section presents the results of the multiple linear regression analysis. Four models were developed for the regression analysis with the SF-12 physical health outcome variable. In doing so, the coefficient of determination R^2 was calculated to measure what percentage of the total variance in SF-12 physical health was explained by the independent variables in each of the four models. P-values were determined to measure the strength of the significant association between the dependent and independent variables. Unstandardized beta coefficients (B) were determined to estimate the effect of each unit of the independent variable on the dependent variable, and standardized beta coefficients (Beta) were calculated to measure the strength of the associations between the dependent and independent variables. Table 3 shows the results of the four models.

Model 1 represents a linear regression analysis of the SF-12 physical health controlling for income. As shown in Table 3, I found the adjusted R^2 value for Model 1 to be 0.029. The unstandardized coefficients (B) and standardized coefficients (Beta) of income were 0.00 and 0.17, respectively, with a p-value of 0.001.

Model 2 represents a linear regression analysis of the SF-12 physical health controlling for income and education. As shown in Table 3, the adjusted R^2 value for Model 2 was found to be 0.060. The unstandardized coefficients (B) and standardized coefficients (Beta) of income were 0.00 and 0.13, respectively, and the p-value was set at <0.001. Similarly, the unstandardized coefficient (B) and standardized coefficient (Beta) values for education were 3.58 and 0.15, respectively, and the p-value was <0.001.

Model 3 represents a linear regression analysis for the SF-12 physical health controlling for income, education, and age. As shown in Table 3, the adjusted R^2 value for Model 3 was calculated to be 0.086. The unstandardized coefficients (B) and standardized coefficients (Beta) of income were 0.00 and 0.12, respectively, while the p-value was <0.001. The unstandardized coefficient (B) and standardized coefficient (Beta) values for education were 3.65 and 0.14, respectively, and the p-value was <0.001. Likewise, the unstandardized coefficient (B) and standardized coefficient (Beta) values for age were -.23 and -0.16, respectively, with a p-value defined to be <0.001.

Table 3. Linear regression for health; regression on income, age, and level of education

Coefficients [a]

	M_1			M_2			M_3			M_4		
	B	Beta	p	B	Beta	p	B	Beta	p	B	Beta	p
Income	0.00	0.17	<0.01	0.00	0.13	<0.01	0.00	0.12	<0.01	0.00	0.10	<0.01
Education				3.58	0.15	<0.01	3.65	0.14	<0.01	3.52	0.15	<0.01
Age							-.23	-.16	<0.01	-.23	-.16	<0.01
Gender										-1.74	-.08	<0.01
(Constant)		45.83			45.27			57.53			60.57	
R^2		0.029			0.060			0.086			0.092	

a. Dependent Variable: SF-12 physical health

Model four represents a linear regression analysis of the SF-12 physical health controlling for income, education, age, and gender. As shown in Table 3, the adjusted R^2 value for Model 4 appeared to be 0.092. The unstandardized coefficients (B) and standardized coefficients (Beta) of income were 0.00 and 0.10, respectively, with a p-value of <0.001. The unstandardized coefficient (B) and standardized coefficient (Beta) values for education were 3.52 and 0.15, respectively, while the p-value was <0.001. The unstandardized coefficient (B) and standardized coefficient (Beta) values for age were -1.23 and -0.16, respectively, while the p-value was found to be <0.001. Finally, the unstandardized coefficient (B) and standardized coefficient (Beta) values for gender were calculated to be -1.74 and -0.08, respectively, with a p-value determined to be <0.001.

5. Discussion

The current study posed a hypothesis that the health status of individuals significantly differs with income level. In analysing the association between income and SF-12 physical health, I found a significant association between income and health. Thus, the null hypothesis is rejected, while the alternative hypothesis is accepted. That is, income is a statistically significant predictor of health. This finding supports the idea of Preston (1975), which states that the relationship between health and income is positive.

Looking at the correlation coefficient between income and health, the study found that income and health are positively correlated. A higher income level increases the chances of having better health status. That is, the higher the income, the more it enables the consumption of health-enhancing goods and services. Accordingly, decreasing income tends to lower health status, particularly for those whose level of income is in the lower part of the income hierarchy.

However, I noted that the correlation coefficient between income and health is weak. It is found that a unit increase in income results in approximately 0.001 units of extra scores of health status. Additionally, I found that income uniquely accounted for a fairly low amount of the variance in health, accounting for only 2.9% of the total variance in health. I therefore conclude that there was a weak linear relationship between income and health among Norwegian adults in 2002.

Turning now to education, I found a statistically significant association between education level and health status. An increase in the level of education demonstrated increased scores of better health status. Thus, the alternative hypothesis is accepted. However, I found a weak positive correlation. More statistically, the results showed that when the education level increased by one unit, the health status increased by 3.58 units and vice versa. The reason for such a relationship, as argued by Zajacov and Lawrence (2018), is that better education can lead to better incomes, healthier lifestyles, health-related knowledge and skills, all of which can help to improve health. This idea is actually related to my finding from the multiple linear regression analysis that education level contributed the most to the variation in health (3.1%), as shown by the increase in R^2 from 2.9% in Model 1 to 6.0% in Model 2.

Regarding age, age is found to be a statistically significant predictor of health. As a result, the alternative hypothesis is accepted. This means that better health scores are observed in younger adults, while poorer health scores are observed in older adults. Therefore, the probability of better health decreases as the adult age increases. Sherbourne et al. argued that this could be due to biological factors. This means that the elderly may be exposed to various molecular and cellular damages over time due to various socio-metabolic causes, resulting in poorer health status scores compared to younger people (Sherbourne et al., 1999). I also noticed that there is a weak negative correlation between age and health. Statistically, it can be said that as the age of individuals increases by one unit, the state of health deteriorates by 0.23 units. Therefore, age was found to be a very weak predictor of health. According to the multiple linear regression analysis, age in the interaction model explains some of the variation in health (2.6%). This is shown by the increase in R^2 from 6.0% in Model 2 to 8.6% in Model 3.

With regard to gender, I found a statistically significant association with health. Adult men were found to have better health scores compared to poorer health scores for adult women. Therefore, the alternative hypothesis is accepted. However, in my analysis, I found a very weak negative correlation between gender and health. Additionally, gender in the regression model was found to supply a very small (0.6%) contribution to health variability.

Summing up, the multivariate regression analysis yielded four models worthy of reporting. Each pattern reveals new information as variables are added. Four independent variables, including income after tax, age, gender, and education level, remained statistically significant but were weak predictors of health. Income and education level are positive predictors, while age and gender are negative predictors. Regression results showed that all four models were statistically significant predictors of health. Moreover, the first model explained only 2.9% of the total variation in health status, while the second model explained 6.0%, the third explained 8.6%, and the fourth model explained 9.2%. From this it can be concluded that among the socioeconomic status variables income and education accounted for two-thirds of (most) the variation in health outcomes, while age and gender accounted for the remaining one-third. However, contrary to hypothesis, income was not the strongest predictor in the multiple regression analysis. In contrast, it is known that education had the strongest effect on variability in health. Thus, the fifth alternative hypothesis is directly rejected.

Finally, despite extensive prior research showing a moderate to strong positive relationship between health and income, my results for this relationship were quite weak. Of course, low values still provide information that both are related and that income can contribute to the variability in health, to some extent. The low values are not surprising because Norway is a welfare state. Therefore, I argue that the low values can be due to Norway systematically regulating the negative effects of income inequality through its institutional mechanism, a generous welfare system. However, the results still suggest that welfare states such as Norway may not be able to avoid the detrimental health effects of income on health in absolute terms.

To close, this study provided interesting and important findings that add to the literature. To name just a few, this study introduced a new universally standardized health outcome measure to examine the relationship between income and health. In addition, this study quantitatively examined the overall and individual impact of socioeconomic status variables on health status.

However, despite the important findings from this study, the study is not without limitations. First, because the study was designed to estimate the impact of income differences on health status and the associations between them, it did not see a cause-and-effect relationship between income and health. Second, because I used data from a cross-sectional survey to examine the relationship between income and health among Norwegian adults, the results of this study cannot reflect the behaviour of the relationship over time. Third, it was interesting to study the adult working-age population, and the possible limited age of the sample was 67 years. Therefore, the results cannot represent the entire Norwegian adult population, especially the elderly.

6. Conclusions and Suggestions

This study examines the relationship between health and income among Norwegian adults aged 40-67. The results showed that there was a significant and direct association between adult income levels and health status. Higher income is associated with better health, while lower income is associated with poorer health. That is, the correlation between income and health is found to be positive. However, their correlation is weak. In addition, I found that income had little effect on the variability of health. Income was found to explain only 2.9% of the variation in health status.

The results show that there is a direct and significant relationship between education level and health status. A higher level of education is associated with better health, and a lower level of education is associated with poorer health. However, I found a weak positive correlation between education level and health status. Likewise, the results show that there is a direct and significant relationship between age and health. Poorer health is associated with older adults and vice versa with younger adults. However, there is a weak positive correlation between age and health status. On the other hand, gender and health status are inversely related. Adult men were more likely to report being in better health than adult women. However, gender is known to have a very weak negative correlation with health.

The results of the regression analysis showed that income, education, age and gender had little influence on the health status of adults. All of these socioeconomic status variables together explain less than 10% of the variation in health. Of these socioeconomic variables, income and education account for two-thirds of (most) the variability in health outcomes, while age and gender account for the remaining one-third. Also, contrary to the assumption, income was not found to be the strongest predictor in the interactive regression analysis. My comparison showed that education was the biggest predictor of variation in health status.

Suggestion for policy practice: I think these results are interesting because, as a welfare state, Norway has institutional mechanisms to redistribute social needs. However, the results indicate that strategic and pragmatic measures must continue to be taken to address health inequalities in a sustainable manner. A more targeted redistribution of social benefits, such as income, with special attention to low-income people, women, less educated and the elderly, is therefore recommended to improve health equality among adults.

Suggestion for future research: there is dearth of empirical research on the moderating effect of welfare systems on income-health relationships, especially among the adult population. With this I suggest that a focus of future research can be to question the moderating effects of welfare systems on the relationship between income and health.

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OSLOMET

Article:

Relationship between Income and Health among Norwegian Adults

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Abstract

Objective: this article analyses the relationship between income and health among Norwegian adults. Its main aim is to estimate the impact of income differences on health status and build a better understanding of their relationship.

Methods: the study uses data from the Norwegian Life Course, Ageing and Generation Study (NorLAG) conducted in 2002. Data were collected through computerized telephone interviews (CATI) and self-administered postal questionnaires. A total of 4183 sampled respondents aged 40-67 were selected for the analysis using a multistage sampling technique. Univariate, bivariate, and multivariate analyses were performed to analyse the relationship between income and health. Both descriptive and inferential statistics were used to present the data.

Results: the results show that there is a statistically significant direct association between income and health. Despite this, income has a weak positive correlation with health, and its impact on variation in health is small. The results also show that differences in education, age, and gender can contribute to variability in health. High education level is associated with better health while the opposite is true for lower education level. Looking at age, older adults are associated with poorer health, while the opposite is true for younger adults. In relation to gender, adult men are associated with relatively better health than adult women. Education is weakly positively correlated with health, while age and gender are weakly negatively correlated. A regression analysis of the interaction of income, education, age and gender showed that they have little influence on the variation in health status. All these socioeconomic status variables together explain less than 10% of the variation in health status. Income and education account for two-thirds (most) of the aggregate variation in health status, while age and gender account for the rest. Income alone accounts for approximately 2.9% of the variation in health status.

Conclusions: income has a weak positive correlation with health and has little impact on variability in health. Contrary to expectation, income was not found to be the strongest predictor of health status. It is known that education had the strongest impact on variability in health.

Key words: Age, Adult, Education, Gender, Health, Income, Norway

Introduction

Health is widely recognized as one of the basic human rights. In 1946, the World Health Organization proposed good health and health equity among the people as a strategic goal for all member states (WHO, 1946). Thus, the Norwegian government has always pursued strategic health goals through the Universal Health and Social Insurance coverage system. This may, of course, be because Norway's form of government is welfare, a generous system of social benefits (Koipysheva, 2018). Therefore, Norway is considered one of the best countries to live in, with high health indicators (Hansen et al., 2012).

Information obtained through scientific research is often considered the most important decision-making tool for achieving strategic health goals and implementing health policy. Research conducted to understand the factors affecting health is one of the most important in this regard. Income, as an important indicator of socioeconomic factors, has received much research attention because of its dominant role in influencing human health status (Preston, 1975; Mackenbach et al, 1997; Li and Zhu, 2006).

Basically, three theoretical foundations can be used for examining the relationship between income and health. These are the absolute income hypothesis, the relative income hypothesis and the income inequality hypothesis. The absolute income hypothesis was formulated to show how the absolute level of an individual’s income (income after tax) affects the individual’s health (Preston, 1975). The relative income hypothesis shows how an individual's relative income position in the income distribution hierarchy affects an individual's health status (Hildebrand and Van Kerm, 2009). The hypothesis of income inequality states that the health status of an individual is affected by the degree of income inequality in which they reside (Mellor and Milyo, 2002; Ettner SL, 1996; Wagstaff, 2003; Van Doorslaer, 2004).

There are also empirical studies showing a relationship between income and health. Researchers have shown a direct relationship between income and health using various measures of health outcomes, such as self-reported health status, life expectancy, and mortality (Adeline and Delattre, 2017; Fiscella and Franks, 2000). Thus, they show that higher income is associated with better health, while lower income is associated with poorer health. They argue that this is because income facilitates access to health services, better housing and sanitation, and adequate nutrition, leading to improved health outcomes, or vice versa (Freeman et al., 2016; Marmot and Wilkinson, 2001).

Nevertheless, most researchers to date have conducted studies at the population or community level, and empirical studies on the relationship between income and health in the adult population are limited. In addition, previous researchers have analysed the relationship between income and health using various health outcomes, such as self-assessed health status reports, life expectancy, and death rate. However, studies using norm-based standardized measures such as the SF-12 of physical health, a multipurpose generic health-related outcome measure of physical function and overall health-related quality of life, are lacking (Ware et al., 1995). Furthermore, in the Nordic welfare system, governments have the opportunity to redistribute income among the population through large tax policies, influencing income impacts and ensuring equal access to health services (Katikireddi, 2019). However, previous studies examining this association were not typical or specific to Nordic welfare systems, nor have they focused on the adult age group of the Norwegian population in question.

In addition, income interaction with other socioeconomic status variables such as education, age and gender can influence health status. There are studies that show individual relationships between health and these socioeconomic status variables. However, there is a lack of adequate research on how income, interaction with these socioeconomic variables, affects health status in target populations (Link and Phelan, 1995; and Bottorff, J.L., 2011).

In light of the above, this study sought to fill a research gap by examining the relationship between income and health among Norwegian adults aged 40-67 using the NorLAG dataset. To achieve this goal, I seek answers to the following research questions: Is there a relationship between income and health status of Norwegian adults aged 40-67? Is there a relationship between educational level, age and gender of Norwegian adults and their health status? Does income inequality affect the health status of Norwegian adults aged 40-67? Do education, age and gender differences affect the health status of Norwegian adults aged 40-67? How much does income affect changes in health status alone and together with education, age and gender?

Literature Review

Empirical Literature

A growing number of studies are investigating the relationship between income and health. Many of these studies support the hypothesis that income is strongly related to health (Adeline and Delattre, 2017; Mackenbach et al., 1997; Marmotetal, 1991; Blackburn, 1994; Chandola, 1998; Preston, 1975; Rodgers, 1979).

During the middle of the 1970s, studies were performed by Fuchs (1974) and Preston (1976) to understand whether the national economy could critically determine population health in industrialized countries. The results of the study have shown that at a certain level of socioeconomic development, additional increases in national income had little effect on increasing national life expectancy (Macinko et al., 2001; Fuchs 1974; Preston 1976). Evidently, the results of these studies were consistent with Omran's epidemiological transition theory that stated that as nations transform to higher levels of economic development, two things are likely to happen. The first is that the cause of human deaths will shift from infectious to chronic, which is called an epidemiological transition. The second is that life expectancy will increase, and the burden of mortality will become significantly composed of old people rather than very young people, which is said to be a demographic transition (Omran, 1971).

Although the majority of early studies have shown the effect of income on population health outcomes, it was in the late 1970s that studies began to be specific to publications that observed the associations of income and health across various social and economic groups within and across the country (Black et al. 1980). When Wilkson (1996) postulated the income inequality hypothesis, the main determinant of differences in health outcomes among developed countries is the magnitude of differences in the disparity between the incomes of the rich and the poor within countries instead of differences in income levels. That is, better health status appears to be positively correlated not only with higher levels of income but, in most cases, even more strongly associated with the equitable distribution of income among the population in a country.

A study that aimed to understand the relationship between income and self-assessed health status using a cross-sectional survey of the British population found that income is significantly associated with health status and appears to be a better predictor of health status than other socioeconomic measures, such as education or occupation (Benzeval et al., 2001).

A recent study of the relationship between income and health in seven European countries, including Belgium, Denmark, England, Finland, France, the Netherlands and Norway, in males and females aged 25 and over, found that people with high incomes are associated with better self-assessed health status in all countries (Mackenbach et al., 2005).

Similarly, a more recent study that examined the health effects of income inequality in developing Asian economies from 1991 to 2019 found that income inequality negatively affects life expectancy. Higher income inequality has a negative effect on health, while less income inequality has a positive effect on health (Chang and Gao, 2021).

Coming to the Norwegian case, a study of whether relative income was associated with individual mortality in Norway between 1994 and 1999 found that low relative income increased the risk of mortality for people with average or lower absolute income when relative income was calculated based on average income in medium-sized or larger populated regions (Elsta et al., 2006). Likewise, a comparative study of life expectancy differences between Norway and the United States showed that Norway had significant and increasing differences in life expectancy by income level between 2005 and 2015 compared to the United States, especially among the lower and middle income groups (Kinge et al., 2019).

Finally, looking at how other socioeconomic status variables, in interaction with income, can affect health status, a study of socioeconomic inequalities in health conducted in 22 European countries found that those with lower education had higher mortality rates than those with higher education (Mackenbach et al., 2008). It is argued that the higher the level of education, the higher the chances of getting a high-paying job. Education thus generates income that improves the health of its beneficiaries (Link and Phelan, 1995). Income differences between younger and older adult age groups are also greater. This is because incomes may decrease for older generations who may be less physically able to work (Link and Phelan, 1995). And research also shows that gender affects people's health. Although various findings showed that women lived longer than men, some studies showed that women have poorer self-rated health response than men. Thus, findings show conflicting results about gender differences in health (Bottorff, J.L., 2011; Warraich and Califf, 2019; Akhtar et al., 2023).

Theoretical Foundation

Several studies have shown a relationship between income and health using different health outcomes. These health outcomes may include, but are not limited to, self-reported health status, life expectancy, and mortality. Using these health outcome measures, researchers predominantly find a direct relationship between income and health. This means that higher incomes are associated with better health (Adeline and Delattre, 2017; Fiscella and Franks, 2000; Benzeval et al., 2001). Researchers argue that this is due to the fact that adequate income allows access to health services, better housing and sanitation, and adequate nutrition, leading to better health outcomes (Freeman et al., 2016; Marmot and Wilkinson, 2001).

Most studies have attempted to examine the relationship between income and health in three different but related ways. In this way, three main hypotheses seem to have been developed to examine the relationship between income and health. They are absolute income hypothesis, the income inequality hypothesis, and the relative income hypothesis.

Absolute income hypothesis: the absolute income hypothesis was established to show how an individual's absolute level of income can impact his or her health. Preston (1975) argues that there is a positive and concave association between absolute income (income after tax in a year) and health. This hypothesis argues that higher incomes have better health outcomes, as they can lend a hand to afford the means for purchasing goods and services that have a relationship with health. However, according to this hypothesis, income inequality and relative income have no direct impact on health. Likewise, Rodgers (1979) argued that the relationship between income and health is concave, that is, each additional amount of an individual's income improves an individual's health status, but by ever smaller amounts. In addition, authors such as Mackenbach et al. (2005) and Carrieri and Jones (2017) also demonstrate a positive association as well as a nonlinear relationship between income and health in their respective studies.

Income inequality hypothesis: the income inequality hypothesis claims that individual health status is affected not only by its own level of income but also by the magnitude of income inequality within the population in the area where they live (Mellor and Milyo, 2002; Ettner SL, 1996; Wagstaff, 2003; Van Doorslaer, 2004). Thus, the level of income inequality within the population equivalently determines the health of both rich and poor individuals, which can be considered a public bad, as income inequality within a population is a threat to the health status of every individual (Adeline and Delattre, 20170).

Different authors have identified three potential pathways by which income inequality may affect health status. The first is the structural pathways argument that states that high income inequality results in settlement isolation of the poor (low well-off), and residential segregation possibly affects individual health (Wen, Browning, and Cagney, 2003). The second is based on the argument that individual health is affected by social relations and social cohesion. This indicates that income inequality affects health by diminishing social cohesion and deteriorating the formation of social capital useful to health (Kawachi et al. 1997). The third argument is linked to policy and strategic pathways that claim that income inequality could impact health status because of the discrepancy between rich and poor individuals influencing the implementation of certain health-related policies (Neckerman and Torche 2007).

Relative income hypothesis: the relative income hypothesis states that health is affected by not only the absolute income level but also by the relative income ranking of individuals in the income distribution hierarchy. Simply put, health deteriorates when income decreases relative to others, and health improves when income increases relative to others. That means that relative income directly affects health outcomes (Hildebrand and Van Kerm, 2009; Cohen, et al., 1997). In this regard, studies show that the attitude of relative disadvantage, whether financial or non-financial, can cause stress and depression in people, which directly or indirectly threatens their health. In other words, relatively well-off people have the financial means to access goods and services that help avoid health risks and vice versa (Markus, 2015; Li and Zhu, 2006).

To sum, while most previous literature points to income inequality and relative income as the main causes of health inequality, my results suggest that absolute income may be a descriptor of health, albeit weakly positively correlated. Thus, my research adds to the literature that argues that absolute income is an important predictor of health.

Hypotheses

As stated in the theoretical framework section of this study, there are three main approaches for studying the systemic relationship between income and health. These include the absolute income hypothesis, the relative income hypothesis, and the income inequality hypothesis (Markus, 2015; Wagstaff, 2003; Preston, 1975). However, due to the type of available data and the research interest, my empirical study is based on the concept of the absolute income hypothesis to answer the above research questions. Therefore, I formulate my first alternative hypothesis as follows:

First Alternate Hypothesis ***(H_1)***: the health status of the high income population is significantly different from the health status of the low income population.

In addition, I hypothesize that the relationship between income and health should be further developed, taking into account the influence of other socio-economic variables. In other words, other important socioeconomic status variables such as education, age and gender, may also significantly influence the relationship. However, I believe that income can play a greater role in explaining the relationship when interact with other socioeconomic status variables. Therefore, I formulate the remaining four alternative hypotheses as follows:

Second Alternate Hypothesis ***(H_2)***: the health status of the population with high education level is significantly different from the health status of the population with low education level.

Third Alternate Hypothesis ***(H_3)***: the health status of the older adult population is significantly different from the health status of the younger adult population.

Fourth Alternate Hypothesis (**H_4**): the health status of the female population is significantly different from the health status of the male population.

Fifth Alternate Hypothesis (***H_5***): comparing the combined interactive effects of income, age, gender, and education, income is the strongest predictor of variations in health status.

Data and Methods

Data Source and Sample Selection

I used data from the Norwegian Life Course, Ageing and Generation Study (NorLAG) to examine the relationship between income and health status among Norwegian adults aged 40–67. NorLAG is administered by the Norwegian Institute for Social Research (NOVA). Statistics Norway, the National Statistical Institute of Norway, in collaboration with NOVA, was responsible for sampling and data collection (Veenstra et al., 2021). Therefore, this article-based thesis has been prepared in accordance with Statistics Norway's rules on the use of statistical results and analyses, including in research.

Three waves of the NorLAG survey have been conducted so far (2002, 2007, and 2017) using computer-assisted telephone interviews (CATI) and self-administered postal questionnaires linked to national registry data. I use data from the first wave conducted in 2002. The sampled respondents were 40 to 80 years old and lived in 24 municipalities and six townships across Norway (Veenstra et al., 2021). The full sample of the first wave includes 9057 respondents, for a response rate of 78%.

However, for analysis, I identified a subsample of 4222 individuals (n=4222), which consists of respondents aged 40-67 in 2002 whose annual income was above zero Norwegian Krone (NOK). The upper age limit was chosen because the normal retirement age in Norway is 67. An income level above zero NOK was chosen because my aim was to study people with a certain income level.

In addition, missing values, such as values for missing respondents, as well as negative values, such as negative income values, were excluded before other statistical operations. I noticed that a total of 39 missing values were recorded. Then, I excluded respondents with missing values for all variables included in the analysis. Therefore, in the end, I am ultimately left with a subsample of 4183 individuals in the analysis.

Dependent and Independent Variables

Five variables were used in the study to conduct the analysis. The variables used in the study are SF-12 norm-based standardized physical health (hereinafter referred to as SF-12 physical health), income after tax, education, age, and gender. I have divided these variables into two broad groups: dependent and independent variables. The SF-12 physical health is the dependent variable, while income after tax, education, age, and gender are the independent variables.

SF-12 physical health is a standardized norm-referenced measure of health outcome on individual's life. It is often used as a measure of quality of life. The SF-12 is a shortened version of the SF-36, which itself evolved from the Medical Outcomes Study. In other words, the SF-12 was developed as a short alternative form of the SF-36 and was created to reduce the burden of response.

The SF-12 is a subset of 12 items covering the same eight health outcome domains of the SF-36 Health Survey (SF-36) (Ware & Sherbourne, 1992; Ware et al., 1993). This includes limitations in physical activities because of health problems (physical functioning), limitations in usual role activities because of physical health problems (role-physical), bodily pain, general health perceptions, vitality (energy and fatigue), social functioning, limitations in usual role activities because of emotional problems (role-emotional), and general mental health (psychological distress and well-being).

SF-12 physical health is a continuous variable scored using norm-based methods. SF-12 physical health scores range from 0 to 100, with higher scores indicating better physical health conditions, while the reverse is true for lower scores (Ware et al., 1995). In general, the SF-12 provides norm-referenced scores. Norm-based scoring linearly transforms scales and summary measures so that they have a mean of 50 and a standard deviation of 10. Because each scale has a standard deviation level of 10, it is easier to see exactly how much below or above the general population mean scores are in standard deviation units, and the health domain scale and summary measurement point comparisons can be made directly (Turner-Bowker and Hogue, 2014).

Annual income after tax is the main independent variable used in the analysis. Income after tax is a continuous variable. As stated above, an annual income level above zero NOK was chosen because the purpose of the study was to examine people with a certain income level.

Education is another variable used in the analysis. Education level is an ordinal categorical variable with eight categories (0 = no education and preschool education, 1 = primary education, 2 = junior education, 3 = upper secondary, basic education, 4 = upper secondary, final education, 5 = postsecondary education, 6 = university and college education, lower level, 7 = university and college education, higher level, and 8 = PhD). I believe that education is classified in detail in the existing dataset, and I decided to re-categorize it to make it more general and simplify the analysis. Therefore, to simplify the analysis, I coded education into three new categories: 1=primary (lower) education level, 2=secondary (middle) education level and 3=tertiary (higher) education level. The primary (lower) education level includes no education and preschool education, primary education, and junior education. The secondary (middle) education level includes upper secondary basic education, upper secondary final education, and postsecondary education. The tertiary (higher) education level includes university and college education lower level, university and college education higher level, and PhD. Again, education is not a metric variable, so I cannot include it in the regression equation. Therefore, I need to create dummy variables for education. Thus, I created a dummy variable for education (0=low and 1=high) for the regression analysis. Low education includes both primary and secondary levels of education, while high education includes higher levels of education in the former category.

Age is another independent variable used in the analysis. Age is a continuous variable. The study used adult respondents whose ages ranged from 40-67 in 2002. As mentioned earlier, the upper age limit was chosen because the normal retirement age in Norway is 67.

Gender is another independent variable used in the analysis. In the data, gender is recorded as a nominal dichotomous categorical variable (1 = male and 2 = female). Because gender is not a numerical variable, it cannot be included in the regression equation. Therefore, I created a gender dummy variable (male is coded 0 and female is coded 1) for the regression analysis.

Method of data analysis

Before analysing the date, a data inspection was done to check whether the data distribution of the dependent variable was normal or not. Histogram, skewness and kurtosis were used for this purpose. Although there are significant values outside the normal curve, the skewness and kurtosis values indicated that the distribution of the data is within the normal range.

Univariate, bivariate and multivariate regression analyses were performed using descriptive and inferential statistical techniques to analysis the data. Univariate analyses were performed to obtain basic information about the variables in the dataset. Univariate analyses were performed using descriptive statistics. Descriptive statistics used for the univariate analyses include range, standard deviation, mean, median, mode, and frequencies.

Bivariate correlation analysis was performed to measure the strength of the linear relationship between the dependent and independent variables and to compute their association. Pearson's correlation was used to measure the linear relationship between two continuous and continuous/categorical variables, while Spearman's correlation was used to measure the linear relationship between two categorical variables. When determining the correlation between the dependent and independent variables, the strength of the association was determined by p-values, while the correlation coefficient (r) values were used to measure the strength and direction of the linear relationship between two variables.

With this in mind, the study expanded the bivariate associations of each independent variable with the dependent variable, such as SF-12 physical health by income, SF-12 physical health by education level, SF-12 physical health by age, and SF-12 physical health by gender.

This study extended the analysis beyond bivariate and performed a stepwise multivariate linear regression analysis. Multiple linear regression analysis was performed to investigate the relationship between the dependent and independent variables and to model the relationship between these variables. Therefore, four models were developed for the regression analysis with the SF-12 physical health as outcome variable controlling for income (Model 1); income and education (Model 2); income, education and age (Model 3); and income, education, age and gender (Model 4) to make predictions about what the dependent variable will do based on the scores of the independent variables. The model is represented by the following equation:

$$y=\beta 0+\beta 1xi1+\beta 2xi2+...+\beta pxip+\epsilon$$

Where, for i=n observations:

y = dependent variable, that is, SF-12 physical health

xi = explanatory variables such as income after tax, education level, age and gender.

$\beta 0$ = y-intercept (constant term), that is, the value of SF-12 physical health where the values of income after tax, education level, age and gender and the error term are zero.

βp = slopes or coefficients for each explanatory variable such as income after tax, education level, age and gender.

ϵ=the model's error term (also known as the residuals)

I used the program SPSS 27 - Statistical Package for Social Sciences to analyse the statistical data. The analysis was run stepwise to see the change in health in each model. Using SPSS, I calculated the coefficient of determination R2 to estimate what percentage of the total variance in SF-12 physical health is explained stepwise by income, education, age, and gender. In other words, the adjusted R-squared was used to measure how much of the variance in health is accounted for by income alone in Model 1; by income and education in Model 2; by income, education and age in Model 3; and by income, education, age and gender in Model 4. Then, I report p-values to measure the significance of the associations, unstandardized beta coefficients (B) to estimate the effect of each unit of the independent variable on the dependent variable, and standardized beta coefficients (Beta) to measure the strength of the associations between the dependent and independent variables.

Results

Univariate Analysis

Univariate analysis was performed to examine each variable independently. It sought to look at the central tendency and dispersion of values, as well as the response patters of each variable. Table 1 describes the characteristics of the data set, summarizing the data samples by gender, age, marital status, educational level, income after tax, and SF-12 physical health.

As shown in Table 1, a total of 4183 samples were selected for the study. The respondents were both men and women. There were slightly more women (51.4%) than men (48.6%). The age of the respondents ranged from 40 to 67 years. The mean, median and mode are used to describe the centrality of the respondents' ages. The average age of the respondents was 53 years. The median age was 53 years, which is the middle score of the adult respondents after it has been arranged in order of magnitude. Fifty years old was the most frequently recorded age in the sampled population, as the mode value was found to be 50.

Table 1. Descriptive Statistics

Variables	Categories	SD	Range	Mean	Median	Mode	Freq.	%
Physical health		10.77	54.33	48.15	53.13	56.58	4183	100
Income after tax		90149	396000	230514	210000	200000	4183	100
Education Level		0.71	2	2.1	2	2	4183	100
	Primary						951	22.7
	Secondary						2036	48.7
	Tertiary						1196	28.6
Age		7.40	27	53.1	53	50	4183	100
Gender		0.5	1	1.5	2	2	4183	100
	Male						2031	48.6
	Female						2152	51.4

With regard to education, frequencies are used to define the description. The samples were described according to their educational level. Of all respondents, 48.7% (2036) had secondary (middle) education, 22.7% (951) had primary (lower) education and 28.6% (1196) had tertiary (higher) education.

As far as annual income after tax is concerned, mean, median and mode can be used to describe the centrality of respondents' income. The average income was NOK 230514.00, the middle income was NOK 210000.00, and the most frequently recorded income was NOK 200000.00. The dispersion of respondents' incomes is estimated using the range and standard deviation. Thus, the range was found to be NOK 396000 while that of the standard deviations was 90149.

With respect to centrality of respondents' SF-12 physical health, the mean can be used to quantitatively describe the SF-12 physical health score. The mean SF-12 physical health score was calculated to be 48.15, which is closer to the standardized SF-12 physical health mean. According to Ware et al. (1995), SF-12 physical health has a mean value of 50, which is an average physical health status. With regards to dispersion of respondents' SF-12 physical health, the standard deviation can be used to show how it is dispersed in relation to the mean. The standard deviation of the SF-12 physical health score was calculated to be 10.77.

Bivariate Analysis

This section presents the results of the bivariate correlation analysis of the dependent and independent variables. When dealing with correlation, it was important to take two steps. First, the strength of the significant association between the dependent and independent variables was determined. The strength of the significant associations between dependent and independent variables is determined by p-values. As shown in Table 2, the calculated p-value was found to be < 0.001 for all variables. Generally, a p-value less than or equal to 0.05 indicates a significant association between variables.

Table 2. Associations of dependent variable with independent variables

		SF-12 physical health
Income after tax	Pearson Correlation	.17**
	Sig. (2-tailed)	.000
	N	4183
Education	Pearson Correlation	.20**
	Sig. (2-tailed)	.000
	N	4183
Age	Spearman's rho	-.18**
	Sig. (2-tailed)	.000
	N	4183
Gender	Spearman's rho	-.10**
	Sig. (2-tailed)	.000
	N	4183

**Correlation is significant at the 0.01 level (2-tailed).

Second, the correlation coefficient was calculated to measure the strength and direction of the relationship between the dependent and independent variables. In this analysis, the dependent variable (SF-12 physical health) was correlated with each independent variable. As shown in Table 2, a weak positive correlation coefficient of r = 0.17 emerged for the relationship between income after tax and SF-12 physical health. The correlation between age and SF-12 physical health was found to be -0.18, interpreted as negative and weak. The correlation between education level and SF-12 physical health appeared to be 0.20, measured as positively weak. Finally, the correlation coefficient between SF-12 physical and gender was calculated as negatively very weak, showing r = -0.10.

Multivariate Regression Analysis

This section presents the results of the multiple linear regression analysis. Four models were developed for the regression analysis with the SF-12 physical health outcome variable. In doing so, the coefficient of determination R^2 was calculated to measure what percentage of the total variance in SF-12 physical health was explained by the independent variables in each of the four models. P-values were determined to measure the strength of the significant association between the dependent and independent variables. Unstandardized beta coefficients (B) were determined to estimate the effect of each unit of the independent variable on the dependent variable, and standardized beta coefficients (Beta) were calculated to measure the strength of the associations between the dependent and independent variables. Table 3 shows the results of the four models.

Model 1 represents a linear regression analysis of the SF-12 physical health controlling for income. As shown in Table 3, I found the adjusted R^2 value for Model 1 to be 0.029. The unstandardized coefficients (B) and standardized coefficients (Beta) of income were 0.00 and 0.17, respectively, with a p-value of 0.001.

Model 2 represents a linear regression analysis of the SF-12 physical health controlling for income and education. As shown in Table 3, the adjusted R^2 value for Model 2 was found to be 0.060. The unstandardized coefficients (B) and standardized coefficients (Beta) of income were 0.00 and 0.13, respectively, and the p-value was set at <0.001. Similarly, the unstandardized coefficient (B) and standardized coefficient (Beta) values for education were 3.58 and 0.15, respectively, and the p-value was <0.001.

Table 3. Linear regression for health; regression on income, age, and level of education

Coefficients [a]

	M_1			M_2			M_3			M_4		
	B	Beta	p	B	Beta	p	B	Beta	p	B	Beta	p
Income	0.00	0.17	<0.01	0.00	0.13	<0.01	0.00	0.12	<0.01	0.00	0.10	<0.01
Education				3.58	0.15	<0.01	3.65	0.14	<0.01	3.52	0.15	<0.01
Age							-.23	-.16	<0.01	-.23	-.16	<0.01
Gender										-1.74	-.08	<0.01
(Constant)		45.83			45.27			57.53			60.57	
R^2		0.029			0.060			0.086			0.092	

a. Dependent Variable: SF-12 physical health

Model 3 represents a linear regression analysis for the SF-12 physical health controlling for income, education, and age. As shown in Table 3, the adjusted R^2 value for Model 3 was calculated to be 0.086. The unstandardized coefficients (B) and standardized coefficients (Beta) of income were 0.00 and 0.12, respectively, while the p-value was <0.001. The unstandardized coefficient (B) and standardized coefficient (Beta) values for education were 3.65 and 0.14, respectively, and the p-value was <0.001. Likewise, the unstandardized coefficient (B) and standardized coefficient (Beta) values for age were -.23 and -0.16, respectively, with a p-value defined to be <0.001.

Model four represents a linear regression analysis of the SF-12 physical health controlling for income, education, age, and gender. As shown in Table 3, the adjusted R^2 value for Model 4 appeared to be 0.092. The unstandardized coefficients (B) and standardized coefficients (Beta) of income were 0.00 and 0.10, respectively, with a p-value of <0.001. The unstandardized coefficient (B) and standardized coefficient (Beta) values for education were 3.52 and 0.15, respectively, while the p-value was <0.001. The unstandardized coefficient (B) and standardized coefficient (Beta) values for age were -1.23 and -0.16, respectively, while the p-value was found to be <0.001. Finally, the unstandardized coefficient (B) and standardized coefficient (Beta) values for gender were calculated to be -1.74 and -0.08, respectively, with a p-value determined to be <0.001.

Discussion

The current study posed a hypothesis that the health status of individuals significantly differs with income level. In analysing the association between income and SF-12 physical health, I found a significant association between income and health. Thus, the null hypothesis is rejected, while the alternative hypothesis is accepted. That is, income is a statistically significant predictor of health. This finding supports the idea of Preston (1975), which states that the relationship between health and income is positive.

Looking at the correlation coefficient between income and health, the study found that income and health are positively correlated. A higher income level increases the chances of having better health status. That is, the higher the income, the more it enables the consumption of health-enhancing goods and services. Accordingly, decreasing income tends to lower health status, particularly for those whose level of income is in the lower part of the income hierarchy.

However, I noted that the correlation coefficient between income and health is weak. It is found that a unit increase in income results in approximately 0.001 units of extra scores of health status. Additionally, I found that income uniquely accounted for a fairly low amount of the variance in health, accounting for only 2.9% of the total variance in health. I therefore conclude that there was a weak linear relationship between income and health among Norwegian adults in 2002.

Turning now to education, I found a statistically significant association between education level and health status. An increase in the level of education demonstrated increased scores of better health status. Thus, the alternative hypothesis is accepted. However, I found a weak positive correlation. More statistically, the results showed that when the education level increased by one unit, the health status increased by 3.58 units and vice versa. The reason for such a relationship, as argued by Zajacov and Lawrence (2018), is that better education can lead to better incomes, healthier lifestyles, health-related knowledge and skills, all of which can help to improve health. This idea is actually related to my finding from the multiple linear regression analysis that education level contributed the most to the variation in health (3.1%), as shown by the increase in R2 from 2.9% in Model 1 to 6.0% in Model 2.

Regarding age, age is found to be a statistically significant predictor of health. As a result, the alternative hypothesis is accepted. This means that better health scores are observed in younger adults, while poorer health scores are observed in older adults. Therefore, the probability of better health decreases as the adult age increases. Sherbourne et al. argued that this could be due to biological factors. This means that the elderly may be exposed to various molecular and cellular damages over time due to various socio-metabolic causes, resulting in poorer health status scores compared to younger people (Sherbourne et al., 1999). I also noticed that there is a weak negative correlation between age and health. Statistically, it can be said that as the age of individuals increases by one unit, the state of health deteriorates by 0.23 units. Therefore, age was found to be a very weak predictor of health. According to the multiple linear regression analysis, age in the interaction model explains some of the variation in health (2.6%). This is shown by the increase in R2 from 6.0% in Model 2 to 8.6% in Model 3.

With regard to gender, I found a statistically significant association with health. Adult men were found to have better health scores compared to poorer health scores for adult women. Therefore, the alternative hypothesis is accepted. However, in my analysis, I found a very weak negative correlation between gender and health. Additionally, gender in the regression model was found to supply a very small (0.6%) contribution to health variability.

Summing up, the multivariate regression analysis yielded four models worthy of reporting. Each pattern reveals new information as variables are added. Four independent variables, including income after tax, age, gender, and education level, remained statistically significant but were weak predictors of health. Income and education level are positive predictors, while age and gender are negative predictors. Regression results showed that all four models were statistically significant predictors of health. Moreover, the first model explained only 2.9% of the total variation in health status, while the second model explained 6.0%, the third explained 8.6%, and the fourth model explained 9.2%. From this it can be concluded that among the socioeconomic status variables income and education accounted for 65% (most) of the variation in physical health outcomes, while age and gender accounted for the remaining 35%. However, contrary to expectations, income was not the strongest predictor in the multiple regression analysis. In contrast, it is known that education had the strongest effect on variability in health. Thus, the fifth alternative hypothesis is directly rejected.

Finally, despite extensive prior research showing a moderate to strong positive relationship between health and income, my results for this relationship were quite weak. Of course, low values still provide information that both are related and that income can contribute to the variability in health, to some extent. The low values are not surprising because Norway is a welfare state. Therefore, I argue that the low values can be due to Norway systematically regulating the negative effects of income inequality through its institutional mechanism, a generous welfare system. However, the results still suggest that welfare states such as Norway may not be able to avoid the detrimental health effects of income on health in absolute terms.

To close, this study provided interesting and important findings that add to the literature. To name just a few, this study introduced a new universally standardized health outcome measure to examine the relationship between income and health. In addition, this study quantitatively examined the overall and individual impact of socioeconomic status variables on health status.

However, despite the important findings from this study, the study is not without limitations. First, because the study was designed to estimate the impact of income differences on health status and the associations between them, it did not see a cause-and-effect relationship between income and health. Second, because I used data from a cross-sectional survey to examine the relationship between income and health among Norwegian adults, the results of this study cannot reflect the behaviour of the relationship over time. Third, it was interesting to study the adult working-age population, and the possible limited age of the sample was 67 years. Therefore, the results cannot represent the entire Norwegian adult population, especially the elderly.

Conclusions

This study examines the relationship between health and income among Norwegian adults aged 40-67. The results showed that there was a significant and direct association between adult income levels and health status. Higher income is associated with better health, while lower income is associated with poorer health. That is, the correlation between income and health is found to be positive. However, their correlation is weak. In addition, I found that income had little effect on the variability of health. Income was found to explain only 2.9% of the variation in health status.

The results show that there is a direct and significant relationship between education level and health status. A higher level of education is associated with better health, and a lower level of education is associated with poorer health. However, I found a weak positive correlation between education level and health status. Likewise, the results show that there is a direct and significant relationship between age and health. Poorer health is associated with older adults and vice versa with younger adults. However, there is a weak positive correlation between age and health status. On the other hand, gender and health status are inversely related. Adult men were more likely to report being in better health than adult women. However, gender is known to have a very weak negative correlation with health.

The aggregate results of the regression analysis showed that income, education, age and gender had little influence on the health status of adults. All of these socioeconomic variables together explain about less than 10% of the variation in health. Of these socioeconomic variables, income and education account for 65% (most) of the variation in health outcomes, while age and gender account for the remaining 35%. Furthermore, contrary to the hypothesis, income was not found to be the strongest predictor in the interactive regression analysis. My comparison revealed that education was the greatest predictor of variation in health status.

Suggestion for future research

There is dearth of empirical research on the moderating effect of welfare systems on income-health relationships, especially among the adult population. With this I suggest that a focus of future research can be to question the moderating effects of welfare systems on the relationship between income and health

Data Availability

The datasets used in this study are available on request from Norwegian Social Research (NOVA). This data can be found here: https://norlag.nsd.no/

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Author Contributions

Hailemariam Andarge wrote the study design, data process, data analysis, and wrote the main manuscript.

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Studies involving animal subjects: No animal studies are presented in this manuscript.

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Inclusion of identifiable human data: No potentially identifiable human images or data is presented in this study.

Competing Interests

The author declares no potential of competing interests.

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