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Personality traits and income inequalities in self-rated oral and general health

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Abstract

The association of low income with poor health is widely recognized, but why some low-income individuals do not experience poor health remains unclear. The aim of this study was to determine whether greater positive personality trait scores modify the association between income and oral and general health-related quality of life (OHRQoL and HRQoL) among a representative sample of the South Australian population. Cross-sectional self-rated questionnaire data from a sample of 3645 adults in 2015–2016 were used for secondary analysis. In four factorial ANOVA models, the main effects, interaction, and effect modification of personality traits [measured using the Ten-Item Personality Inventory (TIPI)] on the association between income and OHRQoL [measured using the Oral Health Impact Profile (OHIP-14)] and HRQoL [measured using the European Quality of Life indicator (EQ-5D-3L)] were assessed. In the low-income group, participants with greater TIPI scale scores had lower means for the OHIP-14 and the EQ-5D-3L (better OHRQoL and HRQoL). Greater emotional stability scores modified the association between low income and HRQoL and OHRQoL. Stronger positive personality traits, such as emotional stability, appear to ameliorate the adverse effect of income inequalities in health.

KEYWORDS

health-related quality of life, patient outcome assessments, personality inventory, population health, socioeconomic status

INTRODUCTION

Despite the large body of literature that shows income gradients in health [1, 2], there is a lack of evidence to explain why some individuals remain healthy despite socioeconomic adversity. Psychosocial factors can be an important resource for low-income people to help them cope with stressors [3]. Positive psychosocial factors such as personality traits can help promote effective coping strategies that help low-income individuals successfully cope with the chronic stress they experience [4, 5].

The Wilson and Cleary model has been used to study the relationship between psychological factors and general and oral health [6, 7]. It explained how characteristics of the individual (e.g., personality) could influence functional health and health-related quality of life (HRQoL) [6, 7]. The link between people's health-related behaviors and personality can be explained using trait theories, such as the

'Big Five' [8]. The Big Five theory defines personality as a combination of five dimensions: extraversion, agreeableness, conscientiousness, openness to experience, and neuroticism [9].

Personality traits have moderating effects (described as modifying effects in the recent literature) [10] on HRQoL [11, 12]. Effect modification is where the effect of one exposure variable on the outcome variable differs at different levels of another exposure, while interaction is the joint effect of two exposures on the outcome variable [13]. People with high scores in extraversion (tendencies to socializing and interactivity), conscientiousness (being self-organized), agreeableness (inclination to be cooperative and affectionate with others), and openness (having greater mental adaptability and flexibility) have been shown to have better HRQoL and oral HRQoL (OHRQoL) [12, 14]. Those scoring high on neuroticism (low emotional stability, that is, having high stress and ineffective coping strategies) have been shown to have poorer HRQoL and OHRQoL [12, 14].

Notwithstanding the number of studies that have assessed the relationship between personality traits and subjective health (and income), this study aimed to fill two gaps in the literature: first, to estimate the interaction effect of the Big Five personality dimensions with income on self-rated health measures such as the Oral Health Impact Profile (OHIP-14) and the European Quality of Life indicator or EuroQol (specifically, the three-level response version, EQ-5D-3L); and second, to determine whether greater positive personality trait scores modify the association between low income and OHRQoL and HRQoL, using a representative population sample in South Australia. The research questions were 'What is the association between income and personality traits (main effects) and their interaction with OHRQoL and HRQoL' and 'Do greater positive personality traits modify the association between low income and general and oral health?'

MATERIAL AND METHODS

Data collection

Data from the Dental Care and Oral Health Study (DCOHS) were used. A total of 12,245 South Australian adults aged 18 years or over were randomly selected from the Electoral Roll. Self-rated questionnaires were mailed to them to participate voluntarily and confidentially in the study (2015–2016) with three follow-up mail reminders. The secondary analysis for this cross-sectional study used the responses from the baseline survey (n = 4494, response rate = 44.8%), which were weighted by population estimates to represent the age and sex distribution of the population of South Australia. The collected data included sociodemographic characteristics, self-rated general and oral health, health-related behaviors, and psychosocial factors. Ethics approval was derived from the Human Research Ethics Committee of the University of Adelaide (H-288-2011) [15, 16].

Outcome variables

The EQ-5D-3L and the OHIP-14 were selected as outcome variables representing HRQoL and OHRQoL, respectively. In the Wilson and Cleary model, the EQ-5D-3L and OHIP-14 conceptually can be considered as functional health [17, 18]. The EQ-5D-3L measures health problems using five items (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression) with three response levels [19]. The EQ-5D-3L was recently psychometrically validated in the general population in Australia and showed acceptable reliability [20]. Responses to the EQ-5D-3L were coded as 0 (no problem/none), 1 (some problems), and 2 (extreme problems) [21] to match the other outcome variable (OHIP-14) as the impact score. Thus, individuals with no problems were anchored at a score of zero. The HRQoL was computed by summing scores across the five items (ranges from 0 to 10), with higher scores representing poorer HRQoL. The OHIP-14 uses 14 items that represent self-reported oral health in seven dimensions (functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap). The OHIP-14 has been validated in Australia, showing good validity and high reliability [22]. Responses were coded with a Likert-type scale from 0 (never) to 4 (very often). The possible score ranges from 0 to 56, and respondents with higher scores have poorer OHRQoL.

Explanatory variable

The explanatory variable was total household income collected in Australian Dollars in 10 categories ranging from <$20,000 to more than $180,000. Income was categorized into three groups (to achieve an approximate even distribution): 0–$40,000, $40,001–$100,000, and >$100,000.

Effect modifier

The effect modifiers were the Ten-Item Personality Inventory (TIPI) dimensions to evaluate the psychosocial factors. The TIPI has been validated in many countries, showing acceptable psychometric validity and test-retest reliability [23–25]. The TIPI was designed as a brief self-rated instrument to measure the Big Five personality dimensions with two items for each trait (a standard item and a reverse-scored item in each trait). These personality dimensions comprise extraversion (being social, enthusiastic), agreeableness (trustworthiness,

being empathetic), conscientiousness (self-discipline, reliability, self-efficacy), emotional stability (the opposite dimension to neuroticism; being balanced, calm, capability of remaining stable), and openness (curiosity and creativity, being open-minded). Each item was rated on a seven-point Likert-type scale ranging from 1 (Disagree Strongly) to 7 (Agree Strongly). Responses to reverse-scored items were recoded (the recoded reverse-scored items) to be consistent with standard items. Then, the average of the standard item and the recoded reverse-scored item were calculated to make up each dimension's scale score which ranged from 1 to 7 (higher scale scores reflecting a higher level of each trait) [23]. Based on the responses, we were able to determine where respondents fell on each trait spectrum. Each TIPI scale score was categorized by the conceptual approach, which was dividing the scale according to whether the scores were equal to being 'agree' or higher (on average) to create two categories: lower TIPI (<5 as disagree) and higher TIPI categories (5–7 as agree). Any dimension scale score that produced agree and higher scores indicated a higher level of that trait and were considered as a higher TIPI category.

Covariates

Other variables included in the models were sociodemographic characteristics (age, sex, place of birth, and the main language spoken at home) and health-related behaviors (smoking status, dental insurance, last dental visit, and tooth brushing). To achieve a roughly even distribution of ages, we divided the population into three age groups (18–45, 46–60, and 61 years and older). Place of birth was coded into two groups (Australian-born or born in other countries). Dental insurance was grouped into insured and uninsured individuals. Language spoken at home was dichotomized as English speakers and non-English speakers. Smoking status was coded into three categories (current smokers, former smokers, and never smoked). Tooth brushing frequency was dichotomized as twice a day, and more or less than twice a day. Similarly, the last dental visit was used to classify respondents into two groups: those who had dental visits <12 months ago or visited the dentist 1 year ago or more.

Data analysis

The study's analysis was limited to the complete cases sample (respondents with full answers to all TIPI dimensions, income, the EQ-5D and the OHIP-14 items; $n = 3645$). Four factorial ANOVA models (general linear models) were conducted to examine the association between TIPI dimensions and income level (main effects) and their interaction with each outcome (the OHIP-14 and then the EQ-5D-3L). First, the simple crude model (model 1) was applied to evaluate the interaction and main effect between TIPI dimensions and income levels. We then used a structured approach to add potential confounders in consecutive blocks. In other words, we added the conceptually relevant covariates (sociodemographic factors and health-related behaviors) in subsequent steps. Thus, model 2 controlled for sex and age. Model 3 adjusted for all of the sociodemographic covariates. Model 4 adjusted for all covariates (sociodemographic factors and health-related behaviors). These four models assessed whether the associations between income and HRQoL (EQ-5D-3L) and OHRQoL (OHIP-14) were modified by different levels of each dimension of the TIPI (Figures S1–S3 in the Supporting Information).

This study focused on the effect sizes of income and personality traits, which are presented using partial ETA-squared (η_p^2). Standardized effect sizes for factorial ANOVA are usually measured by η_p^2. According to the benchmark literature, $\eta_p^2 < 0.0099$ is considered as no effect, a value of η_p^2 between 0.0099 and < 0.0588 is considered a small effect size, and a value of η_p^2 between 0.0588 and < 0.1379 is considered an intermediate effect size [26].

Moreover, to check the factorial ANOVA's assumptions (which apply to residuals instead of the original data values), the skewness and kurtosis values were calculated for the outcome variables (dependent variables). Kurtosis for the OHIP-14 was 5.19, and for the EQ-5D, it was 2.94. Skewness for the OHIP-14 was 2.15, and for the EQ-5D, it was 1.69. These values were interpreted with established benchmarks in the literature as representing sufficient normality. Based on Kim's article [27], for large sample size data 'Either an absolute skew value larger than 2 or an absolute kurtosis (proper) larger than 7 may be used as reference values for determining substantial non-normality'. However, we repeated the analysis using transformed outcome variables (log OHIP-14 and log EQ-5D-3L) to correct for skewness (if any). The results were consistent with the untransformed outcome in terms of effect size, interaction, effect modification, and significance. This justified using the untransformed outcome variables for the main analysis. All analyses were repeated for each scale. SPSS version 28 (IBM) was used for the statistical analysis.

RESULTS

Table 1 demonstrates the characteristics of the sample participants. The majority of respondents were female (55.5%), had dental insurance (68.9%), and never smoked (54.3%). The OHIP-14 and EQ-5D-3L mean scores were the lowest (indicating better OHRQoL and HRQoL) among those non-smokers and dentally insured respondents.

TABLE 1 Descriptive characteristics of the study respondents

	N (%)	OHIP- 14 Mean (SD)	EQ-5D Mean (SD)
Total sample	**3645**	**6.2 (8.6)**	**0.9 (1.3)**
Last dental visit ($n = 3640$)			
Less than a year ago	2245 (61.7 %)	5.8 (8.1)	0.8 (1.2)
A year ago and more	1395 (38.3 %)	6.8 (9.1)	1.0 (1.4)
Dental insurance ($n = 3605$)			
Insured	2484 (68.9 %)	4.9 (6.9)	0.8 (1.2)
Uninsured	1121 (31.1 %)	9.0 (10.7)	1.1 (1.5)
Cigarette smoking ($n = 3626$)			
Non-smoker	1969 (54.3 %)	5.0 (7.2)	0.7 (1.2)
Former smoker	1237 (34.1%)	6.7 (8.6)	1.1 (1.4)
Current smoker	420 (11.6%)	10.8 (12.2)	1.2 (1.5)
Tooth brushing ($n = 3570$)			
Twice a day or more	1956 (54.8 %)	5.5 (8.0)	0.8 (1.2)
Less than twice a day	1614 (45.2 %)	6.9 (8.8)	1.0 (1.3)
Place of birth ($n = 3621$)			
Australia	2866 (79.1 %)	6.0 (8.3)	0.9 (1.2)
Other	755 (20.9 %)	7.4 (9.3)	1.1 (1.4)
Main language spoken at home ($n = 3589$)			
English	3436 (95.7 %)	6.1 (8.5)	0.9 (1.3)
Other	153 (4.3 %)	7.7 (8.5)	1.0 (1.4)
Sex ($n = 3645$)			
Male	1622 (44.5 %)	6.0 (8.1)	0.8 (1.2)
Female	2023 (55.5 %)	6.5 (9.0)	1.0 (1.3)
Age groups (years) ($n = 3645$) (Mean = 52.6) (Range = 18–86)			
18–45	1179 (32.3 %)	5.9 (8.0(	0.6 (1.0)
46–60	1193 (32.8 %)	6.7 (9.3)	0.9 (1.3)
61 and older	1273 (34.9 %)	6.4 (8.8)	1.3 (1.5)

Participants mostly were in the middle-income level (41.2%) and had high TIPI scale scores except for extraversion, where 64.3% had low scores (Table 2). The lowest means of the OHIP-14 and the EQ-5D-3L (better OHRQoL and HRQoL) belonged to the high-income threshold and those with high emotional stability scores.

We fitted a range of generally consistent models, and for reasons of parsimony, only one set is presented in detail, along with the essential findings from the other models. Table 3 presents the association between the TIPI dimensions and household income and their interaction with OHRQoL (OHIP-14) in model 4. There was no evidence for statistical significance of the interaction terms, but small effects for emotional stability (F(1,3424) = 57.5) and income in model 4 were observed. Other personality traits had no association (no effect) with the OHIP-14 in model 4.

In other models, the association between income and the OHIP-14 (models 2 and 3, as presented in Table S3 and S5, respectively) showed an intermediate effect (for openness and agreeableness), while conscientiousness (model 1, as presented in Table S1) and emotional stability (models 1–3, as presented in Table S1, S3, and S5, respectively) still had small effects. There was also a statistically significant association between the interaction effect of income and emotional stability and OHRQoL (OHIP-14) in the other models except for model 4 [model 1 (Table S1), $F(2, 3639) = 7.37$, $p < 0.01$, $\eta_p^2 = 0.004$, Adjusted $R^2 = 0.081$; model 2 (Table S3), $F(2, 3636) = 6.68$, $p < 0.05$, $\eta_p^2 = 0.004$, Adjusted $R^2 = 0.086$; and model 3 (Table S5), $F(2, 3556) = 6.38$, $p < 0.05$, $\eta_p^2 = 0.004$, Adjusted $R^2 = 0.088$].

Table 4 shows the association between income and the five dimensions of the TIPI (main effects) and their interaction effects with the EQ-5D-3L. The interaction effect between income and emotional stability with HRQoL (EQ-5D-3L) in model 4 was statistically significant ($F(2, 3424) = 11.47$, $p < 0.001$, $\eta_p^2 = 0.007$, Adjusted $R^2 = 0.214$). The effect size of

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TABLE 2 Descriptive characteristics of the study respondents by explanatory variable and effect modifiers

	N (%)	OHIP-14 Mean (SD)	EQ-5D Mean (SD)
Total sample	**3645**	**6.2 (8.6)**	**0.9 (1.3)**
TIPI			
Extraversion ($N = 3645$)			
Higher	1302 (35.7%)	5.4 (8.0)	0.7 (1.2)
Lower	2343 (64.3%)	6.6 (8.8)	1.0 (1.3)
Openness ($N = 3645$)			
Higher	2108 (57.8%)	5.8 (8.3)	0.8 (1.2)
Lower	1537 (42.2%)	6.8 (8.8)	1.0 (1.4)
Agreeableness ($N = 3645$)			
Higher	2351 (64.5%)	6.0 (8.4)	0.8 (1.3)
Lower	1294 (35.5%)	6.5 (8.7)	1.0 (1.3)
Conscientiousness ($N = 3645$)			
Higher	2936 (80.5%)	5.7 (8.1)	0.8 (1.2)
Lower	709 (19.5%)	8.1 (9.9)	1.2 (1.5)
Emotional Stability ($N = 3645$)			
Higher	2059 (56.5%)	4.9 (7.4)	0.5 (1.0)
Lower	1586 (43.5%)	7.9 (9.6)	1.3 (1.4)
Income Groups ($n = 3645$)			
≤$40 000	1055 (28.9 %)	9.3 (11.1)	1.6 (1.6)
$40 001–$100 000	1501 (41.2 %)	5.9 (7.7)	0.8 (1.2)
>$100 000	1089 (29.9 %)	4.0 (6.1)	0.5 (0.8)

Abbreviation: TIPI, Ten-Item Personality Inventory.

TABLE 3 Partial eta-squared values of oral health-related quality of life in Model 4 (while controlled for all covariates[a])

	Extraversion	Openness	Agreeableness	Conscientiousness	Emotional stability
Last dental visit	0.001^{NS}	0.001^{NS}	0.001^{NS}	0.001*	0.001*
Dental insurance	0.019**	0.019**	0.019**	0.018**	0.018**
Cigarette smoking	0.028**	0.028**	0.027**	0.025**	0.024**
Tooth brushing	0.005**	0.004**	0.004**	0.004**	0.004**
Place of birth	0.002**	0.003**	0.002**	0.003**	0.002**
Main language spoken at home	0.000^{NS}	0.000^{NS}	0.000^{NS}	0.000^{NS}	0.000^{NS}
Sex	0.004**	0.004**	0.005**	0.004**	0.003**
Age groups	0.005**	0.005**	0.004**	0.004**	0.004**
TIPI	0.001*	0.002**	0.002*	0.006**	0.017**
Income groups	0.024**	0.028**	0.028**	0.022**	0.023**
Income groups * TIPI	0.000^{NS}	0.001^{NS}	0.000^{NS}	0.001^{NS}	0.002^{NS}
Model adjusted R^2	0.116	0.117	0.116	0.120	0.129

Abbreviations: NS, not significant; TIPI, Ten-Item Personality Inventory.

[a]Model 4 controlled for all characteristics (age, sex, place of birth, and the main language spoken at home) and health-related behaviors (smoking status, dental insurance, last dental visit, and tooth brushing).

*$p < 0.05$.

**$p < 0.01$.

TABLE 4 Partial eta-squared values of healt-related quality of life in Model 4 (while controlled for all covariates[a])

	Extraversion	Openness	Agreeableness	Conscientiousness	Emotional stability
Last dental visit	0.001^{NS}	0.001^{NS}	0.001*	0.001^{NS}	0.000^{NS}
Dental insurance	0.001^{NS}	0.001^{NS}	0.001^{NS}	0.001^{NS}	0.001^{NS}
Cigarette smoking	0.011**	0.011**	0.010**	0.009**	0.008**
Tooth brushing	0.003**	0.003**	0.003**	0.002**	0.003**
Place of birth	0.000^{NS}	0.000^{NS}	0.000^{NS}	0.000^{NS}	0.000^{NS}
Main language spoken at home	0.000^{NS}	0.000^{NS}	0.000^{NS}	0.000^{NS}	0.000^{NS}
Sex	0.007**	0.006**	0.008**	0.006**	0.003**
Age groups	0.016**	0.015**	0.019**	0.019**	0.025**
TIPI	0.004**	0.005**	0.009**	0.012**	0.081**
Income groups	0.049**	0.056**	0.056**	0.041**	0.046**
Income groups * TIPI	0.001^{NS}	0.001^{NS}	0.000^{NS}	0.000^{NS}	0.007**
Model adjusted R^2	0.145	0.143	0.146	0.150	0.214

Abbreviations: NS, not significant; TIPI, Ten-Item Personality Inventory.

[a]Model 4 controlled for all characteristics (age, sex, place of birth, and the main language spoken at home) and health-related behaviors (smoking status, dental insurance, last dental visit, and tooth brushing).

*$p < 0.05$.

**$p < 0.01$.

conscientiousness and income on EQ-5D-3L was small, while emotional stability had an intermediate effect size. Other TIPI dimensions had no effects.

Similarly, in models 1–3 (as presented in Tables S2, S4, and S6, respectively), the association between HRQoL (EQ-5D-3L) and income (for all traits except for conscientiousness in models 2 and 3), and emotional stability and HRQoL showed intermediate effects. The association between conscientiousness and HRQoL (models 1–3) showed a small effect (Tables S2, S4, and S6), while agreeableness had a small effect in model 2 (Table S4). Other TIPI dimensions had no effect (Tables S2, S4, and S6). Moreover, there was a statistically significant association between the interaction effect of emotional stability and income with EQ-5D-3L in other models [model 1 (Table S2), $F(2, 3639) = 8.74$, $p < 0.001$, $\eta_p^2 = 0.005$, Adjusted $R^2 = 0.182$; model 2 (Table S4), $F(2, 3636) = 11.16$, $p < 0.001$, $\eta_p^2 = 0.006$, Adjusted $R^2 = 0.210$; and model 3 (Table S6), $F(2, 3556) = 11.75$, $p < 0.001$, $\eta_p^2 = 0.007$, Adjusted $R^2 = 0.209$].

For the model fit statistics, the adjusted R-squared values for oral health outcome (OHIP-14), from model 1 (no covariates, as presented in Table S2) to model 4 (adjusted for all covariates, as presented in Table 4) were 59% to 100% higher. For health outcome (EQ-5D-3L), the adjusted R-squared values increased from 18% to 29% from model 1 (no covariates, as presented in Table S2) to model 4 (fully adjusted model, as presented in Table 4). These higher adjusted R-squared values indicated that the additional input variables were adding additional explanatory value to the models.

The effect modification of emotional stability was observed in the association between different income categories and

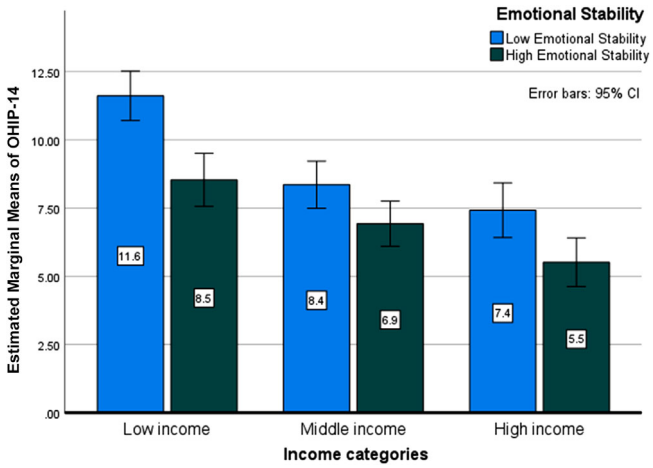

FIGURE 1 Oral health-related quality of life [measured using the Oral Health Impact Profile (OHIP-14)—marginal means and 95% CI] by emotional stability and income levels in Model 4 (while controlled for all covariates; sociodemographic characteristics and health-related behaviors)

OHRQoL in model 4. While there was no statistically significant association between the interaction effect of income and emotional stability and OHRQoL, respondents in the low-income category and with high emotional stability had comparable OHIP-14 (mean = 8.5, 95% CI = [7.6, 9.5]) to others with low emotional stability but in the middle (mean = 8.4, 95% CI = [7.5, 9.2]) and high-income categories (mean = 7.4, 95% CI = [6.4, 8.4]), as shown in Figure 1. Also, the effect modification of emotional stability in the association between income and HRQoL in model 4 was observed,

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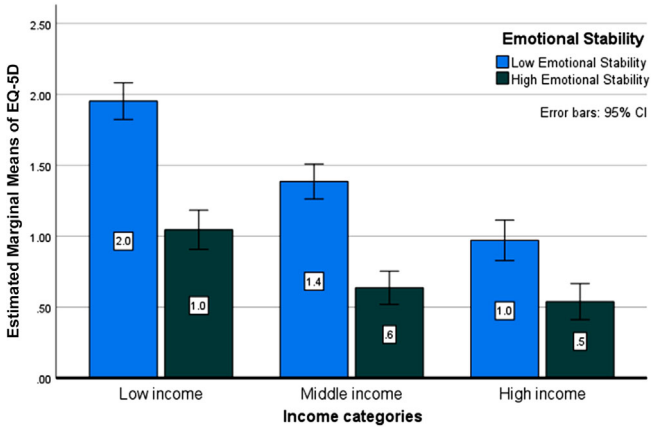

FIGURE 2 Health-related quality of life [measured using the European Quality of Life indicator (EQ-5D)—marginal means and 95% CI] by emotional stability and income levels in Model 4 (while controlled for all covariates; sociodemographic characteristics and health-related behaviors)

where there was evidence for the association between the interaction of income and TIPI dimension with the EQ-5D-3L. The EQ-5D-3L of those at the low-income level and with high emotional stability (mean = 1.0, 95% CI = [0.9, 1.2]) were comparable to participants of high-income status but with low emotional stability (mean = 1.0, 95% CI = [0.8, 1.1]), as shown in Figure 2.

DISCUSSION

This study evaluated the association between income and personality traits (main effects) and their interaction effects with OHRQoL and HRQoL, along with the effect modification of greater positive personality traits in the association between low income and general and oral health. High income and high personality traits such as emotional stability and conscientiousness were associated with better self-reported health measures. The interaction between emotional stability and income was associated with better HRQoL (in all models) and OHRQoL (in models not adjusted for health behaviors). Low-income individuals with greater TIPI scale scores had better OHRQoL and HRQoL than participants with weak TIPI scores. Findings for effect modification suggested that high emotional stability (as a positive personality trait) had a modifying effect in the association between income and OHRQoL and HRQoL.

One of the main interests of this study was the modifying role of personality traits in the association between income and HRQoL and OHRQoL (the effect measure modification analysis). While it is both necessary and desirable to try to improve the social determinants of health, this study assessed whether greater positive personality traits could help to protect low-income people against poor oral and general health. The examination of effect modification allowed us to identify differences in the associations between income (as the exposure) and OHRQoL and HRQoL (as the outcome variables) based on each level of the personality trait dimensions (greater or lower) as the effect modifier [13]. Categorizing personality traits (as the epidemiological exposure measures in a population-based study) in terms of higher and lower scores allowed us to identify the association between the adverse effect of low income and HRQoL and OHRQoL when lower scores on personality traits were contrasted with high. Rothman [28] suggested that one can code exposure variables into categories, while there could be some disadvantages (e.g., the possibility of losing some information, statistical power, and the need for more terms in the model). When the sample size is large, these potential drawbacks are usually insignificant [28]. However, categorization allows for the estimation of effects for each level of exposure without being limited by any specific pattern ('the advantage of the unconstrained estimation of separate effects outweighs the disadvantages in most situations') [28]. Also, by dichotomizing the exposure, it is possible 'to avoid misspecification of the outcome model in interaction analyses' of continuous exposure [29]. According to Richters [30], the use of dichotomous data focuses on individuals' differences instead of variables. Therefore, we can determine what proportion of individuals possess a particular explanatory factor (variable) or combination of explanatory factors, as well as what specific explanatory factors affect the individual (e.g., What is the proportion of people with higher scores on personality traits among low-income individuals? What are the effects of higher scores of personality traits on low-income people's health?). For psychological traits, such as personality, it is important to consider types of individuals rather than assuming homogeneity and where each individual falls on the continuum for each trait (i.e., towards which end of the spectrum).

The greater absolute differences in OHRQoL and HRQoL between respondents with low and high emotional stability in the low-income group (3.1 for the OHIP-14 and 1.0 for the EQ-5D-3L means) than in the high-income group (1.9 for the OHIP-14 and 0.5 for the EQ-5D-3L means) suggested a greater potential health gain from high emotional stability for the low-income group than the high-income group. The findings for effect modification are congruent with past studies that evaluated the moderation effect of personality traits such as emotional stability on the impact of socioeconomic and clinical factors on subjective HRQoL [31–33]. In this study, respondents with greater TIPI scale scores (higher positive personality traits) rated the EQ-5D-3L and the OHIP-14 with the lowest scores (better HRQoL and OHRQoL) across all models unrelated to their income categories. These findings are supported by studies that reported personality characteristics as greater determinants of health and HRQoL

than age [34] and socioeconomic variables like income [35]. Similar to our findings on the main effects of personality traits, low conscientiousness and emotional stability scores have been associated with poor self-rated health [36]. Furthermore, a study on older Japanese reported that participants with low emotional stability scores had poorer OHRQoL, regardless of financial status, number of teeth, and occlusal force [37].

Income-related health inequalities are complex, and addressing them through socioeconomic interventions and anti-poverty programs is difficult. However, it could be possible to improve positive psychosocial factors among low-income groups to help them manage their health problems. This could be achieved through interventions that target psychosocial factors (for example, personality interventions that focus on those traits related to risky health behaviors [38]). Also, holistic approaches such as applying interventions at the community level by using positive psychology for low-income groups [39], mental health promotion programs [40], and providing psychosocial supports and establishing supportive environments for mental health [41, 42] could be beneficial for vulnerable groups. Psychological interventions (using behavioral changes) have shown positive effects in improving oral health behaviors [43].

Although some of the effect sizes found in this study are small, they are still meaningful on the practical level in the related research area. The best approach, especially in social and behavioral epidemiological studies, is to consider practical significance along with statistical significance and effect size. Labelling the effect size depends entirely on the research field and the phenomenon being studied. It should also be noted that small effects can still be important (e.g., when the prevalence of exposure is common, a small effect may impact the population widely, even if relatively small at the individual level). When determining the importance of exposure, the nature of the outcome that is being predicted is more important than the magnitude of the exposure's effect on the outcome [44]. These seemingly small effects could be important in predicting critical life outcomes (such as health) because of their cumulative and practical effects over time [45, 46]. The effects of psychological factors (such as personality traits) that impact behavior and interpersonal relationships can accumulate over time and have an impact on health and quality of life [46]. A perfect example of this is the surprisingly small association between using aspirin and reducing heart attacks. A study of the patients of 10,845 medical doctors found that aspirin prevented only 85 heart attacks [47]. Despite the small effect size of aspirin in that study, the practical significance of the association should not be missed. In terms of cumulative effects, a relatively small effect that has a negative impact on pursuing education at a young age could lead to a significant impact on health and well-being in the future [48].

According to Cohen's suggestion [49], model fit statistics include R-squared values of 0.02, 0.13, and 0.26, which are considered small, medium, and large, in that order. These values in epidemiological studies are usually low, and they do not mean that a model does not fit. We can never expect models (especially in the social or behavioral sciences) to include all relevant predictors that could explain an outcome variable [50, 51].

Income and emotional stability had a significant interaction when adjusted for sociodemographic characteristics. After adjusting for all covariates, the interaction between income and emotional stability was not observed, indicating the effect of adding health behaviors (as covariates). That the improved overall model fit when successive blocks of covariates were added showed that adjusting the models for health behaviors explained new variations in OHRQoL (i.e., health behaviors are associated with the residuals of the crude model), while they decreased the estimated effect of income and personality traits and their interaction effect. Therefore, personality traits cannot fully explain OHRQoL (personality traits have an overlap in variance explained with health behaviors). In other words, health behaviors can explain (to some extent) the association between personality traits and OHRQoL.

The study's strengths comprise a large state-wide representative sample size, using standard and validated self-rated health and personality trait measures, and applying the analysis through four models with different adjusted variables. Limitations include a low response rate (at 44.8%). Despite survey response rates in the last 30 years being usually below 50% [52], response bias (survey dropouts may have different answers from respondents) [53] could be possible. However, the latest evaluations of population data confirmed that the DCOHS (derived from the Electoral Roll as a comprehensive sample frame) broadly represents the age and sex distribution of South Australia's population [15, 16]. Also, the relatively small reduction in sample size caused by missing responses had no major impact on our statistical power due to the large representative sample size we had available to analyze [54, 55].

In conclusion, we assessed the effect of personality trait scores on the self-reported oral and general health measures in a representative sample of the South Australian population. The findings suggested that the associations between income and HRQoL and OHRQoL were modified by emotional stability. Our study found an interaction effect between income and emotional stability with HRQoL and OHRQoL. However, the absence of a statistically significant interaction effect after adjusting for health behaviors suggests that the association between personality traits and OHRQoL can be explained to some extent through health behaviors. This study can help policymakers and researchers design effective interventions that improve personality traits, health, and quality of life.

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CONFLICTS OF INTEREST

The authors declare there are no possible conflicts of interest.

AUTHOR CONTRIBUTIONS

Conceptualization : Mehrsa Zakershahrak, David Brennan; **Methodology**: Mehrsa Zakershahrak, David Brennan; **Formal analysis**: Mehrsa Zakershahrak; **Investigation**: Mehrsa Zakershahrak; **Writing—original draft preparation**: Mehrsa Zakershahrak; **Writing—review and editing**: Mehrsa Zakershahrak, David Brennan; **Supervision**: David Brennan.

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REFERENCES

1. Bernabé E, Sabbah W, Delgado-Angulo EK, Murasko JE, Gansky SA. Income gradients in oral health according to child age. Eur J Oral Sci. 2015;123:260-6.
2. Sabbah W, Tsakos G, Chandola T, Sheiham A, Watt R. Social gradients in oral and general health. J. Dent. Res. 2007;86:992-6.
3. Adler NE, Snibbe AC. The role of psychosocial processes in explaining the gradient between socioeconomic status and health. Curr Dir Psychol Sci. 2003;12:119-23.
4. Atal S, Cheng C. Socioeconomic health disparities revisited: coping flexibility enhances health-related quality of life for individuals low in socioeconomic status. Health Qual Life Outcomes. 2016;14:1-7.
5. Chen E, Strunk RC, Trethewey A, Schreier HM, Maharaj N, Miller GE. Resilience in low-socioeconomic-status children with asthma: adaptations to stress. J Allergy Clin Immunol. 2011;128:970-6.
6. Sousa KH, Kwok O-M. Putting Wilson and Cleary to the test: analysis of a HRQOL conceptual model using structural equation modeling. Qual Life Res. 2006;15:725-37.
7. Wilson IB, Cleary PD. Linking clinical variables with health-related quality of life: a conceptual model of patient outcomes. JAMA. 1995;273:59-65.
8. Booth-Kewley S, Vickers Jr RR. Associations between major domains of personality and health behavior. J Pers. 1994;62:281-98.
9. Caspi A, Roberts BW, Shiner RL. Personality development: stability and change. Annu Rev Psychol. 2005;56:453-84.
10. Knol MJ, VanderWeele TJ. Recommendations for presenting analyses of effect modification and interaction. Int. J. Epidemiol. 2012;41:514-20.
11. Chapman B, Duberstein P, Lyness JM. Personality traits, education, and health-related quality of life among older adult primary care patients. J Gerontol B Psychol Sci Soc Sci. 2007;62:P343-P52.
12. Huang I-C, Lee JL, Ketheeswaran P, Jones CM, Revicki DA, Wu AW. Does personality affect health-related quality of life? A systematic review. PloS one. 2017;12:e0173806.
13. VanderWeele TJ. On the distinction between interaction and effect modification. Epidemiology. 2009;20:863-71.
14. Thomson WM, Caspi A, Poulton R, Moffitt TE, Broadbent JM. Personality and oral health. Eur J Oral Sci. 2011;119:366-72.
15. Song Y, Luzzi L, Chrisopoulos S, Brennan D. Dentist-patient relationships and oral health impact in Australian adults. Community Dent Oral Epidemiol. 2020;48:309-16.
16. Song Y, Luzzi L, Chrisopoulos S, Brennan DS. Are trust and satisfaction similar in dental care settings? Community Dent Oral Epidemiol. 2020;48:480-6.
17. Baker SR, Pearson NK, Robinson PG. Testing the applicability of a conceptual model of oral health in housebound edentulous older people. Community Dent Oral Epidemiol. 2008;36:237-48.
18. Mayo NE, Moriello C, Asano M, van der Spuy S, Finch L. The extent to which common health-related quality of life indices capture constructs beyond symptoms and function. Qual Life Res. 2011;20:621-7.
19. Van Reenen M, Oppe M, Secnik Boye K, Herdman M, Kennedy-Martin M, Kennedy-Martin T. EuroQol research foundation. EQ-5D-3L User Guide. 2018.
20. Zakershahrak M, Ribeiro Santiago PH, Sethi S, Haag D, Jamieson L, Brennan D. Psychometric properties of the EQ-5D-3L in South Australia: a multi-method non-preference-based validation study. Curr Med Res Opin. 2022;38:673-85.
21. Brennan DS. Oral Health Impact Profile, E uro Q ol, and Assessment of Quality of Life instruments as quality of life and health-utility measures of oral health. Eur J Oral Sci. 2013;121:188-93.
22. Slade GD. Derivation and validation of a short-form oral health impact profile. Community Dent Oral Epidemiol. 1997;25:284-90.
23. Gosling SD, Rentfrow PJ, Swann Jr WB. A very brief measure of the Big-Five personality domains. J Res Pers. 2003;37:504-28.
24. Nunes A, Limpo T, Lima CF, Castro SL. Short scales for the assessment of personality traits: development and validation of the Portuguese Ten-Item Personality Inventory (TIPI). Front Psychol. 2018;9:461.
25. Oshio A, Shingo A, Cutrone P. Development, reliability, and validity of the Japanese version of Ten Item Personality Inventory (TIPI-J). JPN J Pers. 2012;21:40-52.
26. Richardson JT. Eta squared and partial eta squared as measures of effect size in educational research. Educ. Res. Rev. 2011;6:135-47.
27. Kim H-Y. Statistical notes for clinical researchers: assessing normal distribution (2) using skewness and kurtosis. Restor Dent Endod. 2013;38:52-4.
28. Rothman KJ. Modern epidemiology. Boston, MA: Little Brown & Co; 1986.
29. VanderWeele TJ, Chen Y, Ahsan H. Inference for causal interactions for continuous exposures under dichotomization. Biometrics. 2011;67:1414-21.
30. Richters JE. The Hubble hypothesis and the developmentalist's dilemma. Dev. Psychopathol. 1997;9:193-229.
31. Allison PJ, Guichard C, Gilain L. A prospective investigation of dispositional optimism as a predictor of health-related quality of life in head and neck cancer patients. Qual Life Res. 2000;9:951-60.
32. Carr VJ, Lewin TJ, Kenardy J, Webster R, Hazell P, Carter GL, et al. Psychosocial sequelae of the 1989 Newcastle earthquake: III. Role

of vulnerability factors in post-disaster morbidity. Psychol. Med. 1997;27:179-90.
33. Kempen GI, Jelicic M, Ormel J. Personality, chronic medical morbidity, and health-related quality of life among older persons. Health Psychol. 1997;16:539.
34. Cederfjäll C, Langius-Eklöf A, Lidman K, Wredling R. Gender differences in perceived health-related quality of life among patients with HIV infection. AIDS Patient Care STDS. 2001;15:31-9.
35. Nesbitt BJ, Heidrich SM. Sense of coherence and illness appraisal in older women's quality of life. Res Nurs Health. 2000;23:25-34.
36. Atherton OE, Robins RW, Rentfrow PJ, Lamb ME. Personality correlates of risky health outcomes: findings from a large Internet study. J. Res. Pers. 2014;50:56-60.
37. Takeshita H, Ikebe K, Kagawa R, Okada T, Gondo Y, Nakagawa T, et al. Association of personality traits with oral health-related quality of life independently of objective oral health status: a study of community-dwelling elderly Japanese. J. Dent. 2015;43:342-9.
38. Edalati H, Conrod PJ. A review of personality-targeted interventions for prevention of substance misuse and related harm in community samples of adolescents. Front. Psychiatry. 2019;9:770.
39. Appiah R, Wilson-Fadiji A, Schutte L, Wissing MP. Effects of a community-based multicomponent positive psychology intervention on mental health of rural adults in Ghana. Appl. Psychol. Health Well-Being. 2020;12:828-62.
40. Castillo EG, Ijadi-Maghsoodi R, Shadravan S, Moore E, Mensah MO, Docherty M, et al. Community interventions to promote mental health and social equity. Psychiatry Rep. 2019;21:1-14.
41. Ritsataki A. Healthy cities tackle the social determinants of inequities in health: a framework for action. World Health Organization. Regional Office for Europe, Copenhagen. 2012.
42. Tsouros AD. Healthy cities: a political movement which empowered local governments to put health and equity high on their agenda. Integrating human health into urban and transport planning. In: Nieuwenhuijsen M, Khreis H, editors. Integrating Human Health into Urban and Transport Planning. Springer, Cham. 2019:73-88.
43. Werner H, Hakeberg M, Dahlström L, Eriksson M, Sjögren P, Strandell A, et al. Psychological interventions for poor oral health: a systematic review. J Dent Res. 2016;95:506-14.
44. Roberts BW, Kuncel NR, Shiner R, Caspi A, Goldberg LR. The power of personality: the comparative validity of personality traits, socioeconomic status, and cognitive ability for predicting important life outcomes. Perspect Psychol Sci. 2007;2:313-45.
45. Abelson RP. A variance explanation paradox: when a little is a lot. Psychol. Bull. 1985;97:129.
46. Funder DC, Ozer DJ. Evaluating effect size in psychological research: sense and nonsense. AMPPS. 2019;2:156-68.
47. Rosenthal R. Effect sizes in behavioral and biomedical research. In Bickman L, editor. Validity and social experimentation: Don Campbell's legacy. Sage Publications, Thousand Oaks, CA. 2000:121-39.
48. Hardarson T, Gardarsdottir M, Gudmundsson KT, Thorgeirsson G, Sigvaldason H, Sigfusson N. The relationship between educational level and mortality. The Reykjavik Study. J. Intern. Med. 2001;249:495-502.
49. Cohen J. Statistical power analysis for the social sciences. Hillsdale, NJ: Erlbaum; 1988.
50. Neter J, Kutner MH, Nachtsheim CJ, Wasserman W. Applied linear statistical models. 4th ed. New York: WCB McGraw-Hill; 1996.
51. Neter J, Wasserman W, Kutner MH. Applied linear statistical models. Homewood, IL: Richard D. Irwin. Inc.; 1974; 842.
52. Baruch Y, Holtom BC. Survey response rate levels and trends in organizational research. Hum Relat. 2008;61:1139-60.
53. Lambert DM, Harrington TC. Measuring nonresponse bias in customer service mail surveys. J. Bus. Logist. 1990;11:5-25.
54. Dziura JD, Post LA, Zhao Q, Fu Z, Peduzzi P. Strategies for dealing with missing data in clinical trials: from design to analysis. Yale J Biol Med. 2013;86:343.
55. Sterne JA, White IR, Carlin JB, Spratt M, Royston P, Kenward MG, et al. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. BMJ. 2009;338:b2393.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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