Can low-income people afford life satisfaction? The modifying effect of personality traits, a cross-sectional study

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Abstract

The aim was to investigate whether the "Big Five" personality traits modify the association between household income and life satisfaction (LF); and to evaluate the interaction and main effects of personality traits and income on LF. Data from the Dental Care and Oral Health Study (DCOHS, 2015–2016) was used for the cross-sectional study (n = 3,475). Multivariable Poisson regression models (adjusted for demographics and health behaviours) assessed the effect of personality traits (measured using the Ten-Item Personality Inventory) on the association between income and LF (measured by the Satisfaction With Life Scale) using prevalence ratios (PRs). The Relative Excess Risk due to Interaction (RERI) was calculated to assess the direction of effect modification. Among low-income respondents, low LF was less prevalent in those with high personality trait scores than those with low scores. The difference in the prevalence of low LF by personality traits was greater between low versus high income for openness (11.4% vs 7.7%), agreeableness (12.3% vs 9.4%) and emotional stability (26.1% vs 20.2%) categories. The combined effects of low income and low scores for these traits on LF also exceeded the sum of their individual effects, as shown by their positive RERIs. The association between low income and low LF was modified by high openness, agreeableness and emotional stability scores. Findings suggest that psychological interventions for improving LF would be most beneficial in low-income groups.

Introduction

The relationship between income and well-being has been studied with a focus on life satisfaction (Diener & Biswas-Diener, 2002). Many studies have shown that higher income is associated with higher life satisfaction (Howell & Howell, 2008; Soto & Luhmann, 2013). Two complementary explanations are plausible for the positive relationship between income and life satisfaction. First, having a high income leads to a high living standard and a comfortable lifestyle (having positive experiences, and avoiding negative experiences) (Christoph, 2010; Gebauer et al., 2013). High income

facilitates consumption, which enhances satisfaction and decreases adverse experiences. Second, income affects life satisfaction through social comparisons (Christoph, 2010). According to Wolbring et al. (2013), comparing one's income with others around them predicts life satisfaction.

So, would it be accurate to conclude that income affects all individuals' life satisfaction in the same way? Or could individual differences (such as personality traits) change this association? Diener et al. (Diener & Biswas-Diener, 2002) reported a weak association between income and life satisfaction. The effect of income on life satisfaction is diminished when basic needs are met (Christoph, 2010; Wolbring et al., 2013). Also, low-income individuals with strong personality traits cope better with stressful and adverse life circumstances (Atal & Cheng, 2016). Therefore, low-income people could have high satisfaction in life with the help of high scores of personality traits. Personality traits are significantly associated with high life satisfaction (Fowler et al., 2018). Those with high scores in extraversion (sociability and having the desire for social interaction), emotional stability (extreme opposite to neuroticism, being balanced and stable), agreeableness (tendency to

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be empathic and help others), conscientiousness (being self-disciplined and diligent), and openness (creativity, curiosity and being open to new experiences) are more likely to feel high life satisfaction (Fowler et al., 2018).

Personality traits also play a crucial role in moderating the complex relationship between income and life satisfaction (Syrén et al., 2020). Recent literature describes the moderating effect as the modifying effect (Knol & VanderWeele, 2012). Effect modification occurs when the association (effect) between the primary exposure and the outcome changes depending on the second exposure stratum (VanderWeele, 2009). The interaction effect refers to where two exposures have a combined effect on the outcome (VanderWeele, 2009). Boyce and Wood (2011) found a positive interaction between income and extraversion and a negative interaction between income and openness in female participants. Also, Proto and Rustichini (2015) reported that openness did not moderate the relationship between income and life satisfaction.

The relationship between an individual's oral and general health-related behaviours to their life satisfaction should also be considered. A positive association between health-related behaviours (such as not smoking) and life satisfaction has been reported (Grant et al., 2009; Shi et al., 2019). Furthermore, according to a study of 200 Romanian medical students (Dumitrescu et al., 2010), there is a strong correlation between oral health behaviours such as regular dental check-ups and toothbrushing with life satisfaction.

While personality traits account for one-third of the variance in life satisfaction (Schimmack et al., 2004), further research is required to explore how personality traits influence income-life satisfaction relationships. Thus, the present study aimed to evaluate the modifying effects of each personality trait on the association between income and life satisfaction among a population sample of South Australian adults. This study investigated the associations between personality traits and income (main effects and their interaction effects) with life satisfaction and whether higher scores on personality traits modify the effect of low household income on low life satisfaction. Our hypotheses were: (i) low household income and low scores for personality traits (individually) would be associated with low life satisfaction; (ii) there would be interaction effects between household income and personality traits on the prevalence of life satisfaction; and (iii) among low-income individuals, the prevalence of low life satisfaction would be lower for those with high scores of personality traits than those with low personality trait scores.

Methods

Study design and data collection

This cross-sectional study used baseline data from the Dental Care and Oral Health Study (DCOHS, 2015–2016),

a prospective cohort study. A sample of 12,245 South Australian adults (18 years or older) from the Electoral Roll was randomly selected to take part in the DCOHS. Participants were invited by mail, and participation was entirely voluntary and confidential. Self-rated mailed questionnaires were sent to respondents and followed by up to three reminders.

The University of Adelaide's Human Research Ethics Committee approved the DCOHS (H-288–2011) (Song et al., 2020a, b).

Final study sample and the representativeness

Of the 12,245 adults invited to participate in the DCOHS, 4,494 respondents completed and returned the survey (44.8% response rate). The analysis was limited to respondents who provided complete responses to all questions related to the exposure (income), effect modifier (personality traits) and outcome (SWLS). Also, respondents with missing responses in covariates were excluded from the analysis, resulting in a final sample size of 3475 individuals.

The final sample was compared against participants with missing responses to account for possible response bias (the possibility of different answers of excluded cases and respondents included in the study). Also, the representativeness of the final study was evaluated by comparing it to census data.

Outcome variable

The overall quality of life was measured using the Satisfaction With Life Scale (SWLS) (based on Wilson and Cleary's model (1995)). The SWLS is a valid and reliable scale (Bendayan et al., 2013) that comprises five items and measures an individual's overall satisfaction with their life on a 5-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree) (Bendayan et al., 2013; Diener et al., 1985). The scale score was calculated by summing the scores across the five items, resulting in a scale score between 5 and 25 (a score of 15 represents neutral SWLS). Higher scores represent higher life satisfaction (overall quality of life). Since the distribution of SWLS among respondents was not normal, scale scores were categorised (St John et al., 2021) as those who were satisfied (higher life satisfaction, i.e., scores 16 or higher) and those who were dissatisfied with their lives (lower life satisfaction, i.e., scores 5–15). The reference category was those who had higher life satisfaction.

Exposure

The total household income before tax was assessed by asking the question, "Which category does your total household

income (before tax) fall into?" with responses in 10 categories (from less than $20,000 to more than $180,000) in Australian Dollars. Income was categorised into two groups: low ($40,000 and less) and high income ($40,001 and more).

Effect modifier

The Big Five personality traits were assessed using the Ten-Item Personality Inventory (TIPI). Gosling et al. (2003) designed TIPI as a short and quick self-report test to assess the Big Five personality traits. TIPI has acceptable psychometric validity and satisfactory test–retest reliability (Gosling et al., 2003; Nunes et al., 2018). Each trait is measured using two items, a standard and a reverse-scored item. Therefore, TIPI has five standard items and five reverse-scored items. Items were scored on a 7-point Likert scale, where 1 = disagree strongly to 7 = agree strongly. The responses to the five reverse-scored items were recoded to match the standard items. Each trait's score was calculated by averaging the standard and the recoded reverse-scored items. Respondents with higher scores have a greater likelihood of showing that trait. Based on the responses, it was possible to determine where each respondent fit on the spectrum of each trait (ranging from 1 to 7). Therefore, each trait was categorised into high and low trait scores using a conceptual approach to divide the scale based on scores that yielded "agree" and higher scores (on average). Those scale scores that yielded "agree" and higher scores (scores 5–7) represented high personality trait scores (high TIPI). The categories comprised those who had high personality trait scores (high TIPI, scores 5–7) and those who had low personality trait scores (low TIPI, scores lower than 5) (Zakershahrak & Brennan, 2022a, b).

Covariates

The other explanatory variables in the models were socio-demographic characteristics and health behaviours. Socio-demographic characteristics included sex, age groups (18–45, 46–60 and 61 years and more), the main language spoken at home (English/ other languages) and birthplace (Australia/ other countries). Health behaviours included dental insurance (insured/ uninsured), smoking status (current/ former/ non-smokers), daily toothbrushing (twice a day or more/ less than twice a day) and the last time for a dental visit (< 12 months ago/ ≥ 12 months ago). The health behaviour covariates represent the general concept of health behaviours, comprising preventive (daily toothbrushing) and risky behaviours (smoking status), along with utilisation (last dental visit) and enabling factors (dental insurance). commonly, these factors tend to bundle or cluster together rather than occur individually (Alzahrani et al., 2014; Sanders et al., 2005).

Statistical analysis

A descriptive analysis was conducted to describe the sample by life satisfaction (outcome). The data was weighted to the South Australian age and sex distribution based on population estimates.

Models

The associations between income and low SWLS with each personality trait were evaluated in four multivariable models using generalised linear models with a log-Poisson link and robust errors. The first model assessed the unadjusted main effects of income categories and personality traits and their interaction effects with low SLWS. Then, conceptually relevant confounders (socio-demographic characteristics and health behaviours) were included sequentially in the analysis using a structured approach (Victora et al., 1997) to assess the adjusted main and interaction effects. Thus, model 1 analyses were adjusted in models 2 to 4 for different sets of covariates (model 2: sex and age—model 3: all socio-demographic characteristics; model 4: all covariates). These four models assessed the interaction effects and main effects of income and each personality trait, along with whether each personality trait modified the association between exposure (income) and low SWLS (outcome) (Figures S1-S3). The prevalence ratio (PR) was calculated as recommended for cross-sectional studies (Barros & Hirakata, 2003). Analyses were conducted using the IBM SPSS 28 software.

The effect measure modification analysis

The effect measure modification (VanderWeele, 2009) analysis was conducted because this study sought to assess whether each personality trait could modify the association between low income and low SWLS. Following Knol & VanderWeele's recommendations (2012), the effect measure modification on the additive scale was assessed by calculating the relative excess risk due to interaction (RERI). The RERI was calculated using the generalized linear models with a log-Poisson link and robust errors to estimate PRs of low SWLS for different levels of income (exposure) and each personality trait (effect modifier) by entering a categorical variable as the exposure. This categorical variable was created by the combination of different levels of income (exposure) and personality traits (effect modifier) as follows:

a. high income and high personality trait score (reference group);
b. high income and low personality trait score;

c. low income and high personality trait score; and

d. low income and low personality trait score.

RERI for each personality trait was estimated using the following formula: PR(d)–PR(b)–PR(c) + PR(a), representing the risk that is in excess of what would be expected if the combination of personality traits and income was entirely additive. RERI was interpreted based on the direction of the effect-measure modification rather than its size, as suggested by Knol and Vander-Weele (2012). A RERI > 0 (i.e., a positive effect measure modification) shows that the combined effects of the low income and low scores of personality traits are greater than the sum of their independent effects on low life satisfaction. A RERI equal to 0 represents no evidence for effect measure modification, and RERI < 0 (negative RERI) shows a negative direction for effect measure modification. STATA 17 was used for calculating RERI.

Separate PRs were also estimated for the effects of low income on low SWLS for each personality trait stratum. The effect modification provided insights into the associations between different levels of exposure (income) with the outcome variable (SWLS) according to each level of the effect modifier (personality traits). Thus, we were able to assess how the association between low income and low life satisfaction (quality of life) changed when respondents had high scores for personality traits.

Knol and VanderWeele (2012) recommend presenting effect modification and interaction in multiplicative and additive scales in order to convey their size and significance. The interaction on an additive scale implies that the combined effect of two exposure variables is greater or smaller than the sum of their individual effects (Knol et al., 2011). The interaction on a multiplicative scale shows that the combined effect of both exposure variables is not equal to (greater/smaller than) the product (multiplication interaction; i.e., low income by low personality trait scores) of the individual effects (Knol et al., 2011). Specifically, the multiplicative interaction compares differences in relative effect measures of association across strata (e.g., the PRs in this study). The additive interaction compares different measures of association across strata (e.g., differences between PRs). The product term of both exposures can be obtained from generalised linear models (e.g., Poisson regression), whereas the additive interaction should be calculated using RERI (if the exposures are binary) (VanderWeele & Knol, 2014). The additive interaction points to which group of the population would most likely benefit from the intervention targeting the effect modifier (VanderWeele & Knol, 2014). The current study investigated interactions on both additive and multiplicative scales.

Results

Participants and data description

A total of 4,494 completed questionnaires were received (44.8% response rate). A total of 3,475 responses were included in the final analysis (after excluding n = 1,019 participants with missing responses). More than half of the study sample were female (55.8%) and non-smokers (54.4%), as presented in Table 1. Over a quarter of the study sample had low life satisfaction (26.2%), and were from the low-income category (27.9%). The prevalence of low life satisfaction was highest among current smokers (43.2%), low-income respondents (38.5%) and those without dental insurance (34.8%).

Most of the study sample had high personality trait scores across four of the five traits. The exception was that only 35.9% of respondents had high extraversion scores, as presented in Table 2. The prevalence of low life satisfaction was highest among respondents with low scores of conscientiousness (42.5%) and emotional stability (39.3%).

Response bias and representativeness of study sample

The final study sample was compared to those with missing answers to evaluate the response bias (Table S1). Overall, excluded participants were similar to the final study respondents. While both samples differed in health behaviours and age groups, the differences were not statistically significant (except for dental insurance, tooth brushing and young and old age groups).

The final sample was compared against the South Australian population data using 2016 census data to assess its representativeness (Table S2). Both populations were broadly similar, except for a higher proportion of Australian-born and high-income individuals and a lower proportion of older participants in the final sample compared to census data.

Main results

The interaction and main effects

Low household income was associated with low life satisfaction across all models, with PRs ranging from 1.95 to 2.70, showing a high prevalence of low life satisfaction among low-income respondents (Table 3, S3-S5). All low personality traits were associated with low life satisfaction across all models. In particular, a higher prevalence of low life satisfaction was observed among those with low scores for conscientiousness (across all

Table 1 Description of the final study sample

	Distributions *(n = 3475)	Low SWLS (low life satisfaction)	
	N (%)	N (%)	95% CI
(n = 3475)		909 (26.2)	24.5–27.9
Health behaviour			
Last Dental Visit			
Within The Past Year	2175 (62.6)	495 (22.8)	20.8–24.9
One Year Ago And More	1300 (37.4)	414 (31.8)	28.9–35.1
Dental insurance			
With Insurance	2411 (69.4)	539 (22.4)	20.5–24.3
Without Insurance	1064 (30.6)	370 (34.8)	31.3–38.5
Smoking Status			
Non-Smoker	1890 (54.4)	426 (22.5)	20.4–24.8
Former Smoker	1189 (34.2)	312 (26.2)	23.4–29.3
Current Smoker	396 (11.4)	171 (43.2)	37.0–50.2
Toothbrushing Frequency			
Twice Daily Or More	1920 (55.3)	426 (22.2)	20.1–24.4
Less Than Twice Daily	1555 (44.7)	483 (31.1)	28.4–34.0
Socio-demographic characteristics			
Country Of Birth			
Australia	2751 (79.2)	706 (25.7)	23.8–27.6
Other Countries	724 (20.8)	203 (28.0)	24.3–32.2
Main Language Spoken At Home			
English Speakers	3331 (95.9)	860 (25.8)	24.1–27.6
Other Languages	144 (4.1)	49 (34.0)	25.2–45.0
Sex			
Male	1536 (44.2)	419 (27.3)	24.7–30.0
Female	1939 (55.8)	490 (25.3)	23.1–27.6
Age Categories (Mean = 52.5)			
18–45 years	1130 (32.5)	299 (26.5)	23.5–29.6
46–60 years	1131 (32.5)	340 (30.1)	27.0–33.4
61 years and older	1214 (35.0)	270 (22.2)	19.7–25.1
Income Categories			
High (> $40,000)	2504 (72.1)	535 (21.4)	19.6–23.3
Low (≤ $40,000)	971 (27.9)	374 (38.5)	34.7–42.6

* The final sample size used for the analysis, including all variables with non-missing data

SWLS: Satisfaction With Life Scale

Table 2 Descriptive characteristics of the final study sample by the effect modifier

	Distributions *(n = 3475)	*Low SWLS (low life satisfaction)*	
	N (%)	N (%)	95% CI
(n = 3475)		909 (26.2)	24.5–27.9
Personality traits			
Extraversion			
Higher	1248 (35.9)	242 (19.4)	17.0–22.0
Lower	2227 (64.1)	667 (30.0)	27.7–32.3
Openness			
Higher	2029 (58.4)	450 (22.2)	20.2–24.3
Lower	1446 (41.6)	459 (31.7)	28.9–34.8
Agreeableness			
Higher	2250 (64.7)	514 (22.8)	20.9–24.9
Lower	1225 (35.3)	395 (32.2)	29.1–35.6
Conscientiousness			
Higher	2832 (81.5)	636 (22.5)	20.7–24.3
Lower	643 (18.5)	273 (42.5)	37.6–47.8
Emotional Stability			
Higher	1966 (56.6)	316 (16.1)	14.3–17.9
Lower	1509 (43.4)	593 (39.3)	36.2–42.6

* The final sample size used for the analysis, including all variables with non-missing data

SWLS Satisfaction With Life Scale

(all models, PRs ranging from 0.66 to 0.71) indicated a significantly greater effect of these traits at the high-income group (Figure S4). The low PRs reflect a lower prevalence of low life satisfaction among high-income respondents with high emotional stability, extraversion and conscientiousness scores (indicating a relatively greater effect for the advantage of high emotional stability, extraversion and conscientiousness scores in the high-income group). There were no statistically significant interactions between income and openness and income and agreeableness across all models (no significant measure of interaction on a multiplicative scale).

The effect measure modification of personality trait

Table 4 presents the analysis of the effect measure modification of each personality trait with the association between low household income and low life satisfaction. Among those with high personality trait scores, the relative effect of income on the prevalence of low life satisfaction was higher (PRs ranging from 1.87 for emotional stability to 2.20 for extraversion) than those with low trait scores (PRs ranging from 1.43 for conscientiousness to 1.85 for agreeableness). Among all respondents, the highest prevalence of low life satisfaction was for those from the low-income group with low personality traits scores (PRs

models, PRs ranging from 1.83 to 2.03) and emotional stability (across all models, PRs ranging from 2.68 to 2.77). The low PRs of the interaction effects (the measure of interaction on a multiplicative scale) between the low-income group and low emotional stability score (models 2–4, PRs ranging from 0.72 to 0.75), low extraversion and lower-income (model 2–4, PRs ranging from 0.73 to 0.75) and low conscientiousness and low income

Table 3 Interaction between personality traits and income with low life satisfaction in the fully adjusted model[†] (Model 4)

	Extraversion PR (95%C.I.)	Openness PR (95%C.I.)	Agreeableness PR (95%C.I.)	Conscientiousness PR (95%C.I.)	Emotional Stability PR (95%C.I.)
Personality Trait (*Ref. Category: High personality trait score category*)	1.61 (1.33–1.95)	1.44 (1.22–1.70)	1.42 (1.20–1.68)	1.83 (1.54–2.18)	2.68 (2.25–3.18)
Low-Income Group (*Ref. Category: High-Income group*)	2.34 (2.5–8.1)	2.01 (1.67–2.43)	2.06 (1.73–2.45)	2.17 (1.84–2.56)	2.15 (1.69–2.74)
Interaction[‡] Between Low-Income Group And Low Personality Trait Score	0.75 (0.57–0.98)	0.90 (0.71–1.13)[*]	0.90 (0.71–1.13)[*]	0.66 (0.52–0.83)	0.72 (0.55–0.94)

PR: Prevalence Ratios

Ref. Category*: Reference Category

[*] Not Significant

[†] Model 4 adjusted for Socio-demographic characteristics (sex, age, main language spoken at home and birthplace) and Health behaviour (daily tooth brushing, smoking status, dental insurance and last dental visit)

[‡] Measure of interaction on multiplicative scale (95% CI)

Table 4 Effect modification of personality trait in the association between income and low life satisfaction from fully adjusted model (model 4)

	Low Income		High Income		PR (95%CI) for low income within strata of personality trait
	N (%) low/high Life satisfaction	PR (95%CI)	N (%) low/high Life satisfaction	PR (95%CI)	
Extraversion					
Low personality trait score	282/411 (40.7/59.3)	2.53 (2.10–3.04)	385/1149 (25.1/74.9)	1.59 (1.34–1.89)	1.79 (1.54–2.08)
High personality trait score	92/186 (33.1/66.9)	2.13 (1.69–2.68)	150/820 (15.5/84.5)	1.00 (Ref.)	2.20 (1.64–2.95)
Measure of interaction on additive scale: RERI (95% CI) = -0.19 (-0.66, 0.27)					
Openness					
Low personality trait score	199/246 (44.7/55.3)	2.37 (2.02–2.78)	260/741 (26.0/74.0)	1.42 (1.22–1.64)	1.78 (1.49–2.13)
High personality trait score	175/351 (33.3/66.7)	1.79 (1.51–2.13)	275/1228 (18.3/81.7)	1.00 (Ref.)	2.10 (1.72–2.57)
Measure of interaction on additive scale: RERI (95% CI) = 0.15 (-0.20, 0.52)					
Agreeableness					
Low personality trait score	144/163 (46.9/53.1)	2.33 (1.97–2.76)	251/667 (27.3/72.7)	1.43 (1.23–1.66)	1.85 (1.52–2.25)
High personality trait score	230/434 (34.6/65.4)	1.88 (1.61–2.21)	284/1302 (17.9/82.1)	1.00 (Ref.)	2.07 (1.72–2.49)
Measure of interaction on additive scale: RERI (95% CI) = 0.01 (-0.36, 0.39)					
Conscientiousness					
Low personality trait score	114/107 (51.6/48.4)	2.47 (2.09–2.93)	159/263 (37.7/62.3)	1.88 (1.61–2.19)	1.43 (1.15–1.79)
High personality trait score	260/490 (34.7/65.3)	1.90 (1.64–2.20)	376/1706 (18.1/81.9)	1.00 (Ref.)	2.15 (1.82–2.56)
Measure of interaction on additive scale: RERI (95% CI) = -0.30 (-0.74, 0.13)					
Emotional stability					
Low personality trait score	256/244 (51.2/48.8)	3.54 (2.99–4.19)	337/672 (33.4/66.6)	2.42 (2.07–2.83)	1.64 (1.42–1.89)
High personality trait score	118/353 (25.1/74.9)	1.92 (1.55–2.37)	198/1297 (13.2/86.8)	1.00 (Ref.)	1.87 (1.41–2.49)
Measure of interaction on additive scale: RERI (95% CI) = 0.19 (-0.30, 0.69)					

Prevalence ratios (PRs) from Model 4 adjusted for: Socio-demographic characteristics (sex, age, main language spoken at home and birthplace) and Health behaviour (daily tooth brushing, smoking status, dental insurance and last dental visit)

ranging from 2.33 to 3.54). The negative measures of RERI for extraversion and conscientiousness indicate negative interaction on an additive scale, showing that the combined effect of low income and low personality trait score (for each of these traits, respectively) was less than the sum of the effects of low income and low personality traits, individually. The positive measures of RERI observed for openness (RERI=0.15, 95% CI [-0.20 – 0.52]) and emotional stability (RERI=0.19, 95% CI [-0.30 – 0.69]), reflected that the combined effects of low income and low scores of each of these traits on low life satisfaction were higher than the sum of their individual effects, in relation to the reference category of high income and high personality trait scores. Low-income respondents with high emotional stability scores reported a comparatively lower prevalence of low life satisfaction (25.1%, PR=1.92) than high-income respondents with low emotional stability scores who reported a higher prevalence of low life satisfaction (33.4%, PR=2.42).

The difference in the prevalence of low life satisfaction between low and high extraversion scores for low-income respondents was 7.6%, while for high-income respondents was 9.6%, inferring a greater effect of high extraversion at high-income level versus low-income level (confirmed by negative RERI) as presented in Table 4. There was a greater difference between low and high openness scores for individuals (11.4%) at the low-income level than at the high-income (7.7%). Among low-income respondents, those with high agreeableness scores (34.6%) had a lower prevalence of low life satisfaction than those with low agreeableness scores (46.9%), with a greater difference at the low-income level between low and high agreeableness scores (12.3%), than at high income (9.4%). The difference in the prevalence of low life satisfaction between low and high conscientiousness scores was lower for low-income (16.9%) versus high-income respondents (19.6%), suggesting a greater effect of high conscientiousness at the high-income level versus low-income level (confirmed by negative RERI). The greater difference in the prevalence of low life satisfaction between low and high emotional stability scores at the low-income level (26.1%) versus the high-income level (20.2%) suggested a greater effect of high emotional stability at the low-income level than at the high-income level. Also, low-income respondents with high conscientiousness scores (34.7%), and high emotional stability scores (25.1%) had a lower prevalence of low life satisfaction than high-income respondents with low conscientiousness (37.7%) and emotional stability scores (33.4%).

Discussion

This study assessed the effect modification of high personality traits in the association between low income and low life satisfaction, along with the interaction and main effects of personality traits and income on low life satisfaction. All models showed strong associations between low scores of

"Big Five" personality traits (extraversion, openness, agreeableness, conscientiousness, and emotional stability) and low life satisfaction. Also, low income was associated with a high prevalence of low life satisfaction (regardless of control for covariates). The interaction effects (the measure of interaction on a multiplicative scale) between low income and low scores for extraversion (adjusted for covariates), conscientiousness (regardless of control for covariates) and emotional stability (adjusted for covariates) with low life satisfaction were observed. High scores of openness and agreeableness positively modified the effect of low income on low life satisfaction, with no significant measure of interaction on a multiplicative scale across all models. Extraversion and conscientiousness negatively modified the effect of low income on low life satisfaction, which along with the low PRs of their interaction effects with income, point to a greater effect of high scores of these traits for high-income respondents. The modifying effects of high emotional stability scores in the association between income and low life satisfaction were observed, suggesting greater opportunities for improving life satisfaction (quality of life) through interventions targeting emotional stability for low-income groups.

The association between low income and low life satisfaction is supported by previous findings (Howell & Howell, 2008; Soto & Luhmann, 2013). Also, recent studies have shown that personality traits moderated the effects of income changes on life satisfaction (Soto & Luhmann, 2013; Syrén et al., 2020), which is in line with the current study's findings. Individuals with high openness scores are better able to adapt to life situations, allowing them to manage their life satisfaction at low-income levels as stressful situations (Kubiszewski et al., 2020; Lee-Baggley et al., 2005). Also, those with high agreeableness scores are more likely to employ adaptive coping strategies when facing a challenging life situation (Lee-Baggley et al., 2005). If their coping strategies are successful, their life satisfaction will be more stable (Kubiszewski et al., 2020).

The current study showed that emotional stability was a protective factor for life satisfaction among low-income individuals. RERI suggested the risk of low life satisfaction due to low income and low emotional stability (high neuroticism) score are beyond what would be expected if the combination of risks due to low income and low emotional stability score (high neuroticism) was entirely additive. Findings suggested the importance of emotional stability for improving life satisfaction among low-income groups. These findings were congruent with previous research stating emotional stability is a significant predictor of life satisfaction (Fowler et al., 2018). Emotionally stable individuals experience low sensitivity to failures and negative experiences (as opposed to high neuroticism) (Soto & Luhmann, 2013). If having low-income results in increased exposure

to negative experiences, and emotionally stable individuals are less likely to be affected by these experiences, then a multiplicative effect is expected (as presented in effect modification findings) for emotionally stable individuals at the low-income level regarding their life satisfaction.

Having higher conscientiousness scores at the low-income level was better (in terms of lower prevalence of poor life satisfaction) or equivalent (in terms of comparable PRs) to having lower conscientiousness scores at the high-income level. Conscientiousness has been shown as a possible beneficial trait for low SES people's health (which is linked to life satisfaction) (Elliot et al., 2017). However, extraversion and conscientiousness did not modify the effect of low income on life satisfaction. These two traits could act as double-edged swords and reduce life satisfaction depending on the situation. High conscientiousness individuals experience high distress from failures and unpleasant life situations (such as financial loss and unemployment) (Boyce et al., 2010). Also, they could be more satisfied with an increase in income to the extent that having more money (collecting wealth) is a potential goal for them (Boyce et al., 2010; Emmons, 1992). Therefore, having low income or being unemployed (which could result in low income) could be in the way to reaching that goal and result in high stress and reduced satisfaction and well-being (Emmons, 1992). Soto and Luhmann (2013) reported similar results that extraversion did not moderate the effects of income on life satisfaction. Also, Syrén et al. (2020) found that extraversion negatively moderated the association between monthly gross income and emotional and mental well-being. Those high in extraversion are more sensitive to their income ranks (Budría and Ferrer-I-Carbonell, 2019). Consequently, where they are (their position) in the income distribution of the reference group has a significant effect on their life satisfaction (Budría and Ferrer-I-Carbonell, 2019). As a result, low income could negatively affect their satisfaction with life. Also, highly extraverted individuals react strongly to positive experiences (Luhmann & Eid, 2009). Given that low income could lead to less frequent positive experiences and the importance of income ranking for extraverted individuals, then it is logical to have a strong association between income and life satisfaction for high extraversion individuals at the high-income level (i.e., a greater effect of high extraversion at high-income level). In other words, a multiplicative effect of low extraversion and low income on their life satisfaction is plausible.

The present study used personality traits as effect modifiers (i.e., explanatory variables), and not clinical case definitions (Zakershahrak & Brennan, 2022a, b). When personality traits are dichotomized, we emphasised the individual differences (as respondents) rather than the homogeneity of these traits (as variables) (Richters, 1997). This way, exposure-outcome association changes could be compared

across effect modifier categories (i.e., higher versus lower personality traits) (VanderWeele, 2009). Categorising exposure has some risks, such as the probability of lower statistical power, need to add more terms in the model and missing some information (Rothman, 1986). Considering the large sample size used in the current study, these risks are insignificant. Also, the benefits of categorising the exposure still outweigh the risks as it allows each exposure level to be assessed individually, without limitations (Rothman, 1986). Another advantage of dichotomisation is that it avoids the possibility of model misspecification in the interaction analyses (VanderWeele et al., 2011).

Notwithstanding the strengths of the current study, including the large and state-representative sample, four multivariable regression models to assess consistent associations and similar patterns, estimates of interactions on both additive and multiplicative scales, and the use of validated and reliable scales, there were some limitations. Foremost among these is the DCOHS response rate of 44.8%, which is congruent with other human research surveys' response rates (below 50%) over the last thirty years (Baruch & Holtom, 2008). This sample was recruited from the Electoral Roll in Australia, which is a comprehensive sample frame. In line with previous studies (Song et al., 2020a, b), DCOHS was broadly representative of the age and sex distributions of the South Australian adult population compared to the general population. In addition, the final sample used for analysis represented the characteristics of South Australian adults, which differed slightly in the country of birth, age distribution, and income groups. It should be noted that the way age and income were categorised in census data differed from the study sample. Also, the final study sample was comparable to participants excluded from the analysis due to missing responses, so there was little evidence of response bias.

The present findings underline the potential role of psychological factors in the possibility of improving life satisfaction (Sakuraya et al., 2020) (which is linked to health (Wilson & Cleary, 1995)) for low-income groups. Psychological interventions using mindfulness programs (Sakuraya et al., 2020) and community-level positive psychology (Montiel et al., 2021) have significantly enhanced life satisfaction. The findings assist health policies and future investigations and multidimensional approaches to address well-being for socioeconomically disadvantaged groups. The current study's findings should be interpreted with bearing in mind that life satisfaction is not the only component of subjective well-being (SWB). The importance of the mental component of quality of life and positive and negative affect as other aspects of SWB (Sakuraya et al., 2020) should not be overlooked.

In conclusion, the current study showed the associations between the "Big Five" personality traits and income with life satisfaction. All personality traits were protective at the

low and high-income levels. In other words, those with high personality trait scores had a lower prevalence of low life satisfaction at both income levels. The most obvious effects were observed for emotional stability and, to some extent, conscientiousness, where there was a clear contrast between low conscientiousness scores at low income and high conscientiousness scores at high income. The effects of high conscientiousness at low income were roughly equivalent to low conscientiousness at high income. Having high scores for emotional stability, openness, and agreeableness were beneficial psychological factors among low-income individuals for their life satisfaction; these findings point to the possibility of improving life satisfaction (quality of life) through interventions targeting these traits for low-income groups. The question "Do personality traits modify the effect of other domains of life (e.g., education, work, relationships, religious belief, and health) on life satisfaction and other aspects of well-being?" needs to be addressed in future research.

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Author contributions MZ and DB conceptualised the idea and designed the models and the computational framework. MZ developed the study, conducted the statistical analysis, interpreted the data and wrote the manuscript. DH contributed to the conception of the study and designing models and critically reviewed the manuscript. DB verified the analysis and supervised the work with the help of DH. SC and LL contributed to editing and critically reviewed the manuscript. All authors have reviewed the results and contributed to the final manuscript.

Data availability Access to the dataset is not permitted because of ethical considerations or privacy concerns.

Declarations

Competing interests The authors have no competing interests to declare that are relevant to the content of this article.

Ethics approval Approval was granted by the Human Research Ethics Committee of the University of Adelaide (H-288–2011). This study was performed in line with the principles of the Declaration of Helsinki.

Consent to participate Participating in the study was voluntary and confidential. Completion of the questionnaire was taken as implied consent. The results were reported in aggregate form, which protected the participant's identity.

Consent to publish Participants were informed via an information sheet that the data would be published in aggregated form, keeping their information confidential.

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