Journal of Biosocial Science (2022), 54: 3, 411–436
doi:10.1017/S0021932021000146

CAMBRIDGE UNIVERSITY PRESS

RESEARCH ARTICLE

Height and quality of life among older adults (50+) in India: a cross-sectional study

Y. Selvamani* and P. Arokiasamy

International Institute for Population Sciences (IIPS), Mumbai, India
***Corresponding author.** Email: selvinsw@gmail.com

(Received 10 September 2020; revised 8 March 2021; accepted 9 March 2021; first published online 14 April 2021)

Abstract

Adult height is a summary measure of health and net nutrition in early childhood. This study examines the association between height and quality-of-life outcomes in older adults (50+) in India. Cross-sectional data from Wave 1 of the World Health Organization (WHO) Study on global AGEing and adult health (SAGE) conducted in 2007 were analysed. The association between height and quality of life was assessed using bivariate and multivariate logistic and linear regression models. The mean WHO quality-of-life score (WHO-QoL) increased from 45.2 among the older adults in the lowest height quintile to 53.2 for those in the highest height quintile. However, the prevalence of self-rated poor quality of life declined from 16.4% in the lowest height quintile to 6.1% in the highest height quintile. In the fully adjusted regression model, height was found to be positively associated with quality-of-life outcomes among both men and women, independent of socioeconomic and physical health confounders. The association was particularly strong for women. Women in the highest height quintile had a 2.65 point higher WHO-QoL score than those in the lowest height quintile. Similarly, the likelihood of reporting a poor quality of life was lower among women in the highest height quintile. Furthermore, measures of economic status, handgrip strength, cognitive ability and poor self-rated health were significantly associated with WHO-QoL and self-rated poor quality of life. Overall, this study revealed a significant association between height and quality of life among older adults in India, suggesting a significant role of childhood circumstances in quality of life in later life.

Keywords: Stature; Early-life conditions; WHO-SAGE

Introduction

India, the second most populous country in the world, is undergoing rapid demographic and epidemiological transition (Chatterji *et al.*, 2008). As a result of a secular decline in fertility and rise in life expectancy, the global phenomenon of population ageing is accelerating in the country. The proportion of the elderly population (aged 60 years or over) in India increased from 6.8% in 1991 to 8.6% in 2011 (Census of India, 2011) and is projected to increase to 19.4% in 2050 (United Nations, 2015).

In India, the growing older population is facing several challenges, including almost negligible formal social and economic support, with most care being provided informally by family members (Ugargol *et al.,* 2016; Ugargol & Bailey, 2018; Bhan *et al.,* 2020). Furthermore, the growing older population is experiencing a changing morbidity profile resulting in a significant health burden and disability and policy challenges (Chatterji *et al.*, 2008; Agarwal *et al.*, 2020). The rising prevalence of chronic conditions has significant implications for the general health and overall quality of life of a population (Arokiasamy *et al.*, 2015). Also, the majority of older adults in India are poor underweight, poor and poorly educated (Ingle & Nath, 2008; Srivastava & Mohanty, 2012;

Selvamani & Singh, 2018), and this is reflected in their poor physical strength, quality of life and cognitive ability (Lee *et al*., 2014; Arokiasamy & Selvamani, 2018).

A high quality of life is important for healthy ageing. The life-course framework adopted by the World Health Organization (WHO) highlights that individual well-being across the different stages of life is an important factor in attaining the Sustainable Development Goals (Kuruvilla *et al*., 2018). The WHO defines quality of life (QoL) as 'the individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals' (WHO-QoL Group, 1993). This covers several dimensions, including physical and mental health, independence, autonomy and the environment. Several indicators have been adapted to understand the quality of life of a population, including a 'happiness' or' life satisfaction' indicator (Banjare *et al*., 2015; Ng *et al*., 2017). Others have used summary scores of measurement scales such as the WHO Quality of Life scale (WHO-QoL) and the Control, Autonomy, Self-realization and Pleasure (CASP) measure (Howel, 2012; Arokiasamy *et al*., 2015), and others used life satisfaction (Chen, 2001) and happiness indices (Moeini *et al*., 2018).

Several studies have identified the major determinants of quality of life in older adults as chronic diseases, physical capacity, frailty, physical activity, nutritional status, back pain, poor mental health, social participation, socioeconomic status, loss of spouse and living arrangements (Chen, 2001; Öztürk *et al*., 2011; Layte *et al*., 2013; Arokiasamy *et al*., 2015; Kojima *et al*., 2016; Raggi *et al*., 2016; Selvamani & Singh, 2018). Also, a growing body of literature suggests the significant role of early-life conditions in determining health and well-being in later life, with childhood health and nutrition playing an important role in determining well-being across the life course. Better childhood socioeconomic status is significantly associated with better health (Cheval *et al*., 2018) and cognitive ability (Aartsen *et al*., 2019; Greenfield & Moorman, 2019) and slow speed of ageing (Steptoe & Zaninotto, 2020).

One marker of childhood health and nutrition is adult height. The height advantage on various health outcomes in later life originates from childhood environmental conditions (Batty *et al*., 2009; Bozzoli *et al*., 2009; Case & Paxson, 2010; Guven & Lee, 2015). The height of an individual is determined by both genetics and net nutrition in early childhood (Silventoinen, 2003; Currie & Vogl, 2013; Perkins *et al*., 2016b). Better nutritional status in childhood is associated with improved height (Victora *et al*., 2008; Case & Paxson 2010). Being tall in childhood is linked to several positive outcomes, such as school achievement, sporting ability and social skills (Cinnirella *et al*., 2011).

Height has been shown to be associated with happiness (Carrieri & De Paola, 2012; Sohn, 2016), life satisfaction (Denny, 2017), health and longevity (Peck & Vågerö, 1989; Silventoinen *et al*., 1999; Fujiwara *et al*., 2014; McGovern, 2014; Ihira *et al*., 2018), attainment of higher level of schooling, higher positions such as professionals and managers and earnings (Strauss & Thomas, 1998; Case & Paxson, 2008b, 2010; Vogl, 2014; LaFave & Thomas, 2017; Patel & Devaraj, 2018; Murasko, 2019, 2020; Ibragimova & Salahodjaev, 2020) and improved well-being (Deaton & Arora, 2009). It is also reflected in better psychological health, with taller individuals having better mental health (Rees *et al*., 2009; Lee & Zhao, 2017) and cognitive ability (Case & Paxson, 2008a; Guven & Lee, 2013, 2015; Kobayashi *et al*., 2019).

Better physical strength and cognitive ability are additional advantages of height (Case & Paxson, 2008a; Guven & Lee, 2013, 2015; McGovern, 2014), and these improve well-being, health and survival (Gottfredson & Deary, 2004; McGuire *et al*., 2006; Gale *et al*., 2007; Newman *et al*., 2006; Leong *et al*., 2015; Batty *et al*., 2016), particularly in developing countries (Lundborg *et al*., 2009).

In India, very few studies have examined the association between height and health-related outcomes. A multi-country study based on the six middle-income countries of India, China, Ghana, Mexico, Russia and South Africa showed a significant association between height and handgrip strength and general health measures such as self-rated health and functional health (McGovern, 2014). However, no previous study has examined the association between height

https://doi.org/10.1017/S0021932021000146 Published online by Cambridge University Press

and quality of life or subjective well-being among the older population in India. Subjective well-being is an important component of healthy ageing. An understanding of the association between childhood circumstances and later-life subjective well-being is important for improving the health and well-being of the older population in India. The effect of early-life conditions on later-life outcomes is stronger in developing countries as childhood shocks are larger (Currie & Vogl, 2013; Perkins *et al.*, 2016b). However, very few studies have examined this (McEniry, 2013), and those that have focused on younger adults. The aim of the present study was therefore to assess the relationship between height and two measures of quality of life among older adults in India. It is hypothesized that a significant and positive association exists between height as a proxy measure of childhood health and nutrition and quality of life among older adults in India.

Methods

Participants and procedure

The study used data from the WHO Study on global AGEing and adult health (SAGE). This cross-country representative household survey of adults age 18–49 and older adults age 50 and above was conducted in six middle-income countries in 2007–10: China, Ghana, India, Mexico, the Russian Federation and South Africa. The survey interviewed 42,236 individuals aged 18 and above. The present analysis focused on 6560 older adult men (n=3304) and women (n=3256) aged 50 years and above in India.

The SAGE survey instruments are comparable to those of the Survey of Health, Ageing and Retirement in Europe (SHARE), the Health and Retirement Study (HRS) and the English Longitudinal Study of Ageing (ELSA) surveys conducted in developed countries. Face-to-face interviews were conducted to obtain data on respondents' socio-demographic characteristics, work history, health behaviours, health risk factors, self-reported and symptomatic assessment of chronic conditions, subjective health, quality of life, cognitive ability, disabilities and health care utilization. Also, objective measures of health and anthropometric measures, including height, weight, handgrip strength, lung function, hypertension, waist and hip circumferences, timed walk and a vision test were made. A detailed description and documentation of data are described elsewhere (Kowal *et al.*, 2012), and data can be freely downloaded from the WHO website (http://apps.who.int/healthinfo/systems/surveydata/index.php/catalog/sage).

Outcome variables

The study had two quality-of-life outcome variables: the WHO Quality of Life (WHO-QoL) score and 'self-rated poor quality of life'.

The WHO-QoL score was based on two SAGE survey questions in each of four broad domains (eight items in total): physical, psychological, social and environmental (Schmidt *et al.*, 2006). A five-point scale was used to capture the response, ranging from 'very satisfied' to 'very dissatisfied'. A Quality of Life Index (WHO-QoL) was generated by combining the four different domain scores. The domain composite scores and the WHO-QoL ranged from 0 to 100, with a higher score meaning a higher quality of life.

The 'self-rated quality of life' variable was assessed through a single question: 'How would you rate your overall quality of life?' The response categories were: 1) very good, 2) good, 3) moderate, 4) bad and 5) very bad. These were re-coded into the two categories 'good' (combining very good, good and moderate) and 'poor' (combining bad and very bad).

https://doi.org/10.1017/S0021932021000146 Published online by Cambridge University Press

Predictor variable

The predictor variable was height. In the SAGE survey, this was measured by trained investigators in centimetres using a stadiometer. In the present study, heights were put into quintiles (lowest to highest) to examine the association between height and quality-of-life outcomes.

Covariates

Handgrip strength

'Handgrip strength' was measured in the SAGE survey using a Smedley Hand Dynamometer (Scandidact Aps, Denmark). With their upper arm against their body and elbow bent to 90 degrees and the palm facing inwards (like shaking hands), participants were asked to squeeze the dynamometer as hard as possible for a several seconds. Four observations were made and the best one used as the 'handgrip strength' score. Sex-specific handgrip quintiles (lowest, second, third, fourth and highest) were generated to examine the association between handgrip strength and quality-of-life outcomes.

Cognitive ability

A composite 'cognitive functioning index' was generated by combining four domains of cognition: verbal fluency, verbal recall, digit span forward and digit span backward, and used to create a 'cognition variable'.

To assess 'verbal recall' the interviewer read out a list of ten commonly used words and asked the respondent to repeat them in a certain time. For 'digit span (forward and backward)', participants were read a series of digits and asked to repeat them immediately. In the backward test, the person had to repeat the numbers in reverse order. These tests measure concentration, attention and immediate memory.

'Verbal fluency' was assessed by asking participants to name as many animals as possible in a one-minute time span. This test assesses the retrieval of information from the semantic memory.

A composite cognitive ability index was derived using Principal Components Analysis (PCA) – a mathematical tool that helps create a composite index using uncorrelated components, where each component captures the largest possible variation in the original variables (Vyas & Kumaranayake, 2006). Selected raw scores for cognitive tasks were bundled into three domains (digit span, memory and executive functioning) to yield compound cognitive scores. This was done to condense the number of cognitive variables while refining the robustness of the underlying cognitive construct (Lezak *et al.*, 2004). Two steps were used to make the composite cognitive ability index. As the four variables were on different scales, in Step 1 a standardized variable was created (z-score or standard score) by re-scaling each variable to have a mean of zero and a standard deviation of one. Each case's value on the standardized variable designates its difference from the mean of the primary variable in some standard deviations (of the original variable). In Step 2, PCA was applied. The resulting index had both positive and negative values; the scores were converted into an index ranging from 0 to 100 for ease of interpretation. Higher scores indicate better cognitive ability. The 'cognitive ability' variable was divided into five quintiles (lowest, second, third, fourth and highest).

Body mass index

Body mass index (BMI, kg/m^2) was categorized as underweight ($<$18.5), normal weight (18.5–24.9), overweight (25.0–29.9) and obese ($\leq$30.0).

https://doi.org/10.1017/S0021932021000146 Published online by Cambridge University Press

Self-reported chronic conditions

Selected chronic diseases and a edentulism variable were included as risk factors of quality of life (Emami *et al*., 2013; Arokiasamy *et al*., 2016). The SAGE survey included information on the self-reported prevalence of chronic diseases, collected with the question 'Have you ever been diagnosed with [name of the chronic disease]? Five chronic conditions were included in the analysis; high blood pressure, diabetes, angina, arthritis and asthma. The prevalence of edentulism was assessed in the survey with the question 'Have you lost all of your natural teeth? Those who reported 'yes' were considered as edentulous.

Poor self-rated health

Self-rated health was assessed through a single question 'In general, how would you rate your health today?'. The response categories were: 1. very good, 2. good, 3. moderate, 4. bad and 5. very bad. These were re-coded into two categories 'very good',' good' and 'moderate' as 'good self-rated health' and 'bad' and 'very bad' into 'poor self-rated health'.

Socio-demographic characteristics

The socio-demographic covariates included in the analysis were age (50–59, 60–69 and 70+), place of residence (urban and rural), marital status (currently married and not currently married), years of education (0–5, 6–9 and 10+ years) and wealth quintile (poorest, poorer, middle, richer and richest).

Statistical analyses

Bivariate analysis was conducted to understand the sample distribution. Weighted mean quality of life and prevalence of self-rated poor quality of life by height quintile were estimated. Sex-stratified bivariate and multivariate linear regression models were used to assess the association between height and WHO-QoL. A logistic regression model was used to examine the relationship between height and self-rated poor quality of life. Five different models were estimated to better understand the role of socioeconomic status and handgrip strength in mediating the relationship between height and quality of life outcomes. Model 1 only included the height variable, and in a step-wise manner, Model 2 included demographic characteristics, Model 3 included socioeconomic status and Model 4 included selected chronic diseases, BMI and poor self-rated health. In Model 5, handgrip strength and cognitive ability were included along with those in Model 4. Multivariate linear regression models were used to understand the predictors of height. Multivariate linear and logistic regression analyses were used to understand the association of height with WHO-QoL and self-rated poor quality of life by age group. All statistical analyses were implemented using STATA 15.0 (Stata Corp LP).

Results

The characteristics of the study population are shown in Table 1. The mean height of the study population was 156.7 cm, the mean WHO-QoL score was 49.2 and the mean cognitive ability score and handgrip strength scores were 38.1 and 23.4, respectively. Around 11% of participants reported having a poor quality of life. A larger proportion of the sample was in the age group of 50–59. More than half of older adults had no schooling. The overall prevalence of hypertension and arthritis was higher than that of other chronic health conditions. The prevalence of poor self-rated health was 22.0%. The mean values of height, handgrip strength, cognitive ability and WHO-QoL score were lower in women than in men. The prevalence of self-rated poor quality of life was higher among women. A larger proportion of men (91.4%) were currently married than women (61.9%). A higher proportion of men (27%) than women (4%) had completed

https://doi.org/10.1017/S0021932021000146 Published online by Cambridge University Press

Table 1. Characteristics of the study population (weighted), India, WHO-SAGE Wave 1, 2007[a]

Variable	Total (*N*=6560)	Men (*N*=3304)	Women (*N*=3256)
Height, cm (mean±SD)	156.7±9.97	163.4±7.78	149.8±6.80
Weight, kg (mean±SD)	50.4±13.4	53.8±13.0	46.9±12.9
Grip strength, kg (mean±SD)	23.4±9.32	28.2±9.09	18.4±6.49
Cognitive ability score (mean±SD)	38.1±10.0	41.4±9.50	34.5±9.29
WHO-QoL score (mean±SD)	49.2±12.2	50.9±11.8	47.5±12.4
Self-rated poor quality of life	10.8	9.5	12.1
Age group			
50–59	48.6	49.4	47.8
60–69	30.9	29.9	31.9
70+	20.5	20.7	20.3
Place of residence			
Urban	28.9	28.3	29.5
Rural	71.1	71.7	70.5
Marital status			
Currently married	76.9	91.4	61.9
Not currently married	23.1	8.6	38.1
Schooling (years)			
No schooling	51.6	31.0	73.1
1–5 years	19.1	22.5	15.6
6–9 years	13.1	19.4	6.5
10+ years	16.2	27.2	4.9
Wealth quintile			
Poorest (Ref.)	18.2	17.3	19.1
Poor	19.5	19.1	19.9
Middle	18.8	18.4	19.2
Richer	19.6	21.0	18.2
Richest	23.9	24.2	23.6
BMI			
Underweight	38.3	39.4	37.2
Normal weight	48.3	50.6	45.9
Overweight	10.6	8.2	13.2
Obese	2.8	1.9	3.7
Poor self-rated health	22.4	19.7	25.3
Edentulism	15.1	13.9	16.4
Hypertension	17.0	13.8	20.3

(*Continued*)

https://doi.org/10.1017/S0021932021000146 Published online by Cambridge University Press

Table 1. (*Continued*)

Variable	Total (*N*=6560)	Men (*N*=3304)	Women (*N*=3256)
Diabetes	6.9	8.2	5.6
Arthritis	18.2	15.5	21.0
Asthma	7.2	9.0	5.4
Angina	5.5	6.9	4.2

[a]Values in percentages unless indicated otherwise.

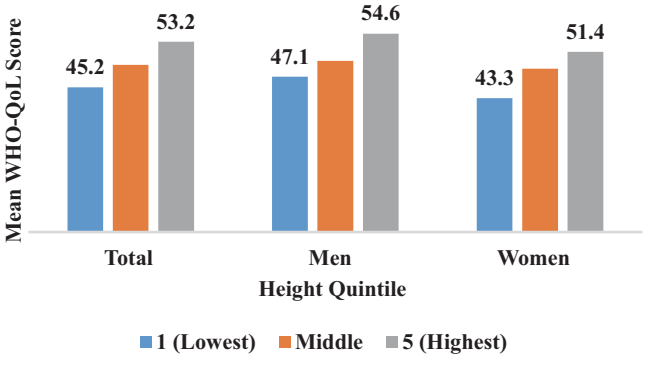

Figure 1. Mean WHO-QoL score by height quintile among older adults in India, WHO-SAGE, 2007.

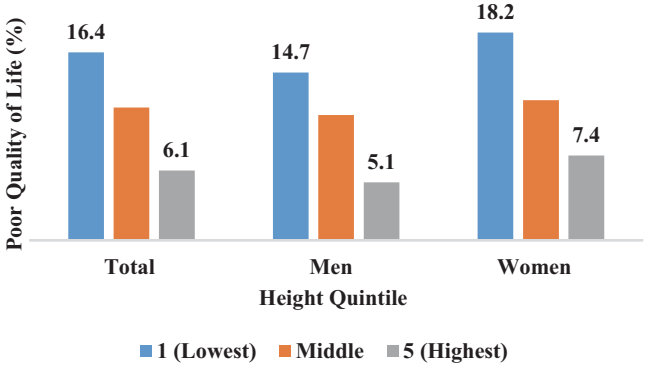

Figure 2. Prevalence of poor quality of life (%) by height quintile among older adults in India, WHO-SAGE, 2007.

10+ years of schooling. The prevalence of underweight was higher among men. A higher proportion of women reported poor self-rated health, edentulism, hypertension and arthritis than men.

Figure 1 shows the WHO-QoL score by height quintile for the total sample by sex. The mean WHO-QoL score increased from 45 among older adults in the lowest height quintile to 53 among those in the highest height quintile. Men (47.1) and women (43.3) in the lowest height quintile had lower mean WHO-QoL scores than the men (54.6) and women (51.4) in the highest quintile.

Figure 2 shows the prevalence of self-rated poor quality of life by height quintile and sex. The prevalence for the whole sample declined from 16.4% in the lowest height quintile to 6.1% in the highest height quintile (Figure 2) For men, it declined from 14.7% in the lowest height quintile to 5.1% in the highest height quintile. Women in the lowest height quintile (18.2%) reported a higher prevalence of poor quality of life than those in the highest height quintile (7.4%).

https://doi.org/10.1017/S0021932021000146 Published online by Cambridge University Press

Table 2. Correlates of height (cm) among older men and women in India, WHO-SAGE Wave 1, 2007

Variable	Men	Women
	β (95% CI)	β (95% CI)
Age		
50–59 (Ref.)		
60–69	−1.26*** (−1.87, −0.66)	−1.62*** (−2.16, −1.08)
70+	−1.90*** (−2.60, −1.20)	−3.61*** (−4.26, −2.95)
Place of residence		
Urban (Ref.)		
Rural	0.46 (−0.19, 1.13)	0.32 (−0.25, 0.91)
Schooling (years)		
0–5 years (Ref.)		
6–9 years	0.46 (−0.27, 1.20)	0.67 (−0.26, 1.61)
10+ years	1.13*** (0.40, 1.86)	0.61 (−0.45, 1.68)
Wealth quintile		
Poorest (Ref.)		
Poor	0.61 (−0.27, 1.51)	0.76* (−0.04, 1.56)
Middle	1.32*** (0.42, 2.23)	0.91** (0.09, 1.72)
Richer	2.15*** (1.24, 3.05)	1.50*** (0.70, 2.31)
Richest	3.82*** (2.88, 4.76)	2.25*** (1.44, 3.06)
Adjusted R^2	0.0517	0.0511
Sample size	3193	3135

β=coefficient value; CI=Confidence Interval.
*$p<0.05$; **$p<0.01$; ***$p<0.001$.

Table 2 shows the association of height with socio-demographic variables by sex. Age was negatively associated with height among older adults and wealth quintile was significantly and positively associated with height.

Table 3 presents the regression results of height and WHO-QoL for men The results of the multivariate regression analysis showed a positive association between height and WHO-QoL score among older men (Table 3). Across the different regression models, the association between height and WHO-QoL was positive and statistically significant among men. In the final regression model, men in the highest height quintile had a 1.87 point higher quality-of-life score than those in the lowest height quintile ($p<0.001$). The coefficient of height quintile declined with the inclusion of schooling, wealth quintile, handgrip strength and cognitive ability. The association between wealth quintile and WHO-QoL was strong and significant. Similarly, the association of handgrip strength and cognitive ability with WHO-QoL was significant and positive. The prevalence of chronic diseases such as high blood pressure, asthma, arthritis and angina was negatively associated with the WHO-QoL score. The association between poor self-rated health and WHO-QoL score was highly significant and negative. Measures of socioeconomic status, along with handgrip strength and cognitive ability, played important roles in mediating the relationship between height and WHO-QoL score.

Table 4 presents the regression results of height and WHO-QoL for women. The association between height and WHO-QoL was significant and positive across five different regression

https://doi.org/10.1017/S0021932021000146 Published online by Cambridge University Press

Table 3. Bivariate and multivariate linear regression results of the association between height and WHO-QoL among older men in India, WHO-SAGE Wave 1, 2007

	Model 1	Model 2	Model 3	Model 4	Model 5
Variable	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Height quintile					
1 (Lowest) (Ref.)					
2	2.79*** (1.53, 4.06)	2.07*** (0.84, 3.30)	1.64*** (0.47, 2.80)	1.27** (0.23, 2.32)	1.15** (0.09, 2.21)
3	3.03*** (1.78, 4.29)	2.41*** (1.19, 3.64)	1.65*** (0.49, 2.81)	1.85*** (0.81, 2.89)	1.67*** (0.62, 2.73)
4	5.04*** (3.78, 6.30)	3.95*** (2.72, 5.19)	2.48*** (1.31, 3.65)	2.45*** (1.40, 3.50)	2.20*** (1.13, 3.28)
5 (Highest)	6.09*** (4.84, 7.35)	5.05*** (3.82, 6.29)	2.72*** (1.54, 3.90)	2.31*** (1.26, 3.37)	1.87*** (0.78, 2.96)
Age					
50–59 (Ref.)					
60–69		−3.15*** (−4.04, −2.26)	−2.81*** (−3.66, −1.96)	−1.60*** (−2.37, −0.84)	−1.26***(−2.0, −0.48)
70+		−6.08*** (−7.12, −5.04)	−5.60*** (−6.59, −4.60)	−2.72*** (−3.65, −1.79)	−2.25***(−3.22, −1.29)
Place of residence					
Urban (Ref.)					
Rural		−3.03*** (−3.95, −2.11)	0.39 (−0.53, 1.31)	0.54 (−0.29, 1.38)	0.55 (−0.28, 1.40)
Marital status					
Currently married (Ref.)					
Not currently married		−0.11 (−1.32, 1.10)	0.35 (−0.79, 1.49)	0.34 (−0.68, 1.37)	0.54 (−0.50, 1.58)
Schooling (years)					
No schooling (Ref.)					
1–5 years			0.17 (−0.82, 1.17)	0.32 (−0.57, 1.22)	−0.148 (−1.07, 0.77)
6–9 years			1.03* (−0.09, 2.15)	0.87* (−0.13, 1.87)	0.078 (−0.97, 1.12)
10+ years			3.71*** (2.58, 4.85)	3.16*** (2.13, 4.19)	2.09***(0.99, 3.2)
Wealth quintile					

(*Continued*)

https://doi.org/10.1017/S0021932021000146 Published online by Cambridge University Press

Table 3. (*Continued*)

Variable	Model 1 β (95% CI)	Model 2 β (95% CI)	Model 3 β (95% CI)	Model 4 β (95% CI)	Model 5 β (95% CI)
Poorest (Ref.)					
Poor			2.85*** (1.60, 4.11)	2.43*** (1.31, 3.55)	2.11*** (0.97, 3.25)
Middle			4.35*** (3.08, 5.62)	4.12*** (2.98, 5.26)	3.81*** (2.66, 4.97)
Richer			6.05*** (4.78, 7.32)	5.14*** (3.99, 6.29)	4.82*** (3.65, 5.99)
Richest			10.2*** (8.90, 11.5)	8.79*** (7.58, 10.0)	8.35*** (7.12, 9.59)
Health marker					
No reported health condition (Ref.)					
High blood pressure				−1.94*** (−2.93, −0.95)	−1.97*** (−2.97, −0.97)
Diabetes				−0.03 (−1.31, 1.23)	−0.21 (−1.49, 1.06)
Asthma				−3.61*** (−4.81, −2.40)	−3.64*** (−4.87, −2.42)
Arthritis				−2.17*** (−3.10, −1.24)	−2.11*** (−3.06, −1.17)
Angina				−1.19 (−2.65, 0.26)	−0.83 (−2.31, 0.65)
Edentulism				−1.43*** (−2.42, −0.45)	−1.21** (−2.21, −0.20)
Poor self-rated health				−10.9*** (−11.8, −10.0)	−10.2*** (−11.1, −9.29)
BMI					
Underweight				−0.89** (−1.64, −0.14)	−0.45 (−1.22, 0.31)
Normal weight (Ref.)					
Overweight				0.30 (−0.89, 1.49)	0.08 (−1.11, 1.28)
Obese				1.22 (−1.22, 3.67)	1.59 (−0.95, 4.13)
Handgrip strength					
1 (Lowest) (Ref.)					
2					0.38 (−0.67, 1.43)

(*Continued*)

Table 3. (*Continued*)

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
3					0.65 (−0.43, 1.74)
4					1.03* (−0.09, 2.16)
5 (Highest)					1.44** (0.22, 2.66)
Cognitive ability					
1 (Lowest) (Ref.)					
2					0.64 (−0.43, 1.72)
3					1.29** (0.18, 2.41)
4					1.36** (0.19, 2.52)
5 (Highest)					3.07*** (1.82, 4.32)
Adjusted R^2	0.031	0.0829	0.1958	0.3578	0.3536
N	3221	3221	3193	3192	3090

β=coefficient value; CI=confidence interval.
***$p<0.001$; **$p<0.005$; *$p<0.01$.

Table 4. Bivariate and multivariate linear regression results on the association between height and WHO-QoL among older women in India, WHO-SAGE Wave 1, 2007

Variable	Model 1 β (95% CI)	Model 2 β (95% CI)	Model 3 β (95% CI)	Model 4 β (95% CI)	Model 5 β (95% CI)
Height quintile					
1 (Lowest) (Ref.)					
2	2.29*** (1.01, 3.57)	1.53** (0.28, 2.79)	1.265** (0.05, 2.47)	1.2** (0.12, 2.27)	0.74 (−0.38, 1.87)
3	3.93*** (2.62, 5.23)	2.68*** (1.39, 3.98)	2.25*** (1.00, 3.49)	2.00*** (0.88, 3.11)	1.56*** (0.39, 2.72)
4	4.64*** (3.35, 5.93)	3.36*** (2.09, 4.64)	2.41*** (1.18, 3.64)	1.83*** (0.72, 2.93)	1.20** (0.048, 2.36)
5 (Highest)	7.00*** (5.70, 8.30)	5.67*** (4.38, 6.96)	4.46*** (3.20, 5.71)	3.54*** (2.42, 4.66)	2.65*** (1.46, 3.84)
Age					
50–59 (Ref.)					
60–69		−0.89* (−1.82, 0.027)	−0.74 (−1.63, 0.14)	−0.17 (−0.97, 0.62)	0.006 (−0.82, 0.83)
70+		−2.67*** (−3.87, −1.47)	−2.91*** (−4.07, −1.75)	−1.29** (−2.35, −0.22)	−0.70 (−1.84, 0.43)
Place of residence					
Urban (Ref.)					
Rural		−2.96*** (−3.86, −2.06)	−0.049 (−1.00, 0.90)	0.19 (−0.66, 1.05)	0.33 (−0.54, 1.21)
Marital status					
Currently married (Ref.)					
Not currently married		−3.77*** (−4.6, −2.88)	−2.81*** (−3.68, −1.95)	−2.23*** (−3.01, −1.46)	−2.05*** (−2.85, −1.25)
Schooling (years)					
No schooling (Ref.)					
1–5 years			−1.20** (−2.31, −0.10)	−0.69 (−1.68, 0.29)	−0.95* (−1.99, 0.08)
6–9 years			1.21 (−0.32, 2.75)	1.69** (0.31, 3.06)	1.03 (−0.42, 2.48)
10+ years			3.46*** (1.71, 5.22)	3.33*** (1.75, 4.90)	2.57*** (0.89, 4.26)

(*Continued*)

Table 4. (*Continued*)

Variable	Model 1 β (95% CI)	Model 2 β (95% CI)	Model 3 β (95% CI)	Model 4 β (95% CI)	Model 5 β (95% CI)
Wealth quintile					
Poorest (Ref.)					
Poor			2.60*** (1.29, 3.90)	2.18*** (1.01, 3.34)	2.06*** (0.84, 3.27)
Middle			4.37*** (3.05, 5.68)	3.69*** (2.51, 4.87)	3.65*** (2.42, 4.87)
Richer			6.49*** (5.18, 7.81)	5.50*** (4.31, 6.69)	5.43*** (4.20, 6.66)
Richest			9.39*** (8.06, 10.7)	8.24*** (7.02, 9.46)	8.14*** (6.87, 9.42)
Health marker					
No reported health condition (Ref.)					
High blood pressure				−1.92*** (−2.83, −1.00)	−1.61*** (−2.55, −0.66)
Diabetes				−1.24* (−2.68, 0.198)	−1.13 (−2.63, 0.36)
Asthma				−2.13*** (−3.6, −0.60)	−2.48*** (−4.13, −0.83)
Arthritis				−2.51*** (−3.38, −1.63)	−2.38*** (−3.29, −1.47)
Angina				−1.24 (−3.02, 0.52)	−1.27 (−3.07, 0.53)
Edentulism				0.89* (−0.11, 1.90)	1.12** (0.06, 2.18)
Poor self-rated health				−10.6*** (−11.5, −9.83)	−10.3*** (−11.3, −9.4)
BMI					
Underweight				−1.13*** (−1.93, −0.33)	−0.75* (−1.59, 0.08)
Normal weight (Ref.)					
Overweight				0.32 (−0.75, 1.40)	0.24 (−0.85, 1.34)
Obese				−0.34 (−2.04, 1.34)	−0.49 (−2.2, 1.24)
Handgrip strength					
1 (Lowest) (Ref.)					
2					0.94* (−0.13, 2.01)

(*Continued*)

Table 4. (*Continued*)

Variable	Model 1 β (95% CI)	Model 2 β (95% CI)	Model 3 β (95% CI)	Model 4 β (95% CI)	Model 5 β (95% CI)
3					1.39** (0.25, 2.5)
4					1.31** (0.17, 2.46)
5 (Highest)					2.71*** (1.48, 3.93)
Cognitive ability					
1 (Lowest) (Ref.)					
2					1.84*** (0.71, 2.98)
3					1.28** (0.14, 2.43)
4					0.35 (–0.83, 1.54)
5 (Highest)					2.24*** (0.92, 3.57)
Adjusted R^2	0.0371	0.0849	0.1592	0.3304	0.3249
N	3161	3161	3135	3124	2912

β=coefficient value; CI=confidence interval.
***$p<0.001$; **$p<0.005$; *$p<0.01$.

models, with women (final model) in the highest height quintile having a 2.65 higher WHO-QoL score than those in the lowest height quintile ($p<0.001$). Women who were currently not married had a significantly lower WHO-QoL score. Furthermore, wealth quintile and educational attainment showed a positive association with WHO-QoL score. High blood pressure, asthma, arthritis, edentulism and poor self-rated health were negatively associated with WHO-QoL among women. Also, handgrip strength and cognitive ability showed a positive association with WHO-QoL among women.

Table 5 shows the results of the logistic regression analysis of the association between height and self-rated poor quality of life among older men. The association between height and self-rated poor quality of life was statistically significant up to Model 4, and with the inclusion of handgrip strength and cognitive ability variables in Model 5, the association became insignificant. The association between wealth quintile and self-rated poor quality of life was negative and highly significant. The association between poor self-rated health and self-rated poor quality of life was positive and highly significant. The association between height and self-rated poor quality of life among women was significant across all regression models but the association was weak in Model 5 (Table 6). Furthermore, the factors marital status, wealth quintile, asthma, poor self-rated health and underweight were all significantly associated with self-rated poor quality of life. The age-stratified regression analysis suggested a stronger association between height and quality of life outcomes for the 50–59 and 70+ age groups (Table 7).

Discussion

Using data from WHO-SAGE, this study examined the association between height and quality-of-life outcomes among older adults (aged over 50 years) in India. Height was found to be positively associated with the WHO quality-of-life measure (WHO-QoL) and self-rated poor quality of life measures, independent of demographic, socioeconomic and health confounders. In particular, the association was consistent and stronger for women. Wealth quintile showed a strong association with quality-of-life outcomes among these older adults. Chronic diseases showed a negative association with quality of life. Furthermore, the association of handgrip strength and cognitive ability with quality of life was significant and positive, and the association between wealth quintile and height was also positive and significant.

The results of this study are consistent with those in the literature. Deaton and Arora (2009) found a significant association between height and overall quality of life in the US adult population. A study based on data from Indonesia found height to be a significant predictor of happiness among younger adults (Sohn, 2016). Similarly, a significant relationship between height and subjective well-being measures has been demonstrated (Carrieri & De Paola, 2012; Denny, 2017). Coste *et al.* (2012) found a weak association between height and health-related quality of life among adults aged 18–50. Several studies have also found a strong association between height and health outcomes. Case and Paxson (2008a), in their study based on Health and Retirement Study (HRS) data, documented a significant relationship between height and physical and mental health outcomes among the elderly population in the United States. In a cross-country investigation, McGovern (2014) found a significant relationship between height and several health outcomes, including handgrip strength, general health, activities of daily living and lung function in six low- and middle-income countries.

The effects of poor early-life conditions have been shown to be greater in low-income settings, mainly as a result of larger childhood shocks (Currie & Vogl, 2013; Perkins *et al.*, 2016b). Early-life conditions, such as nutrition, childhood mortality and socioeconomic circumstance, play an important role in determining adult height (Bozzoli *et al.*, 2009; Mamidi *et al.*, 2011; Tucker-Seeley & Subramanian, 2011; Perkins *et al.*, 2016b). Studies across the globe have found a significant relationship between early-life circumstances and health, mortality and economic and

https://doi.org/10.1017/S0021932021000146 Published online by Cambridge University Press

Table 5. Bivariate and multivariate logistic regression results on the association between height and self-rated poor quality of life among older men in India, WHO-SAGE Wave 1, 2007

Variable	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)	Model 5 OR (95% CI)
Height quintile					
1 (Lowest) (Ref.)					
2	0.71** (0.51, 0.91)	0.75* (0.53, 1.04)	0.76 (0.53, 1.07)	0.84 (0.58, 1.21)	0.88 (0.60, 1.30)
3	0.67** (0.48, 0.94)	0.71** (0.51, 0.99)	0.75 (0.53, 1.073)	0.74 (0.51, 1.07)	0.76 (0.51, 1.13)
4	0.48*** (0.33, 0.69)	0.527*** (0.36, 0.76)	0.64** (0.43, 0.94)	0.62** (0.41, 0.93)	0.70 (0.46, 1.07)
5 (Highest)	0.42*** (0.29, 0.62)	0.471*** (0.32, 0.69)	0.67* (0.45, 1.00)	0.78 (0.51, 1.18)	0.93 (0.60, 1.44)
Age					
50–59 (Ref.)					
60–69		1.50*** (1.14, 1.97)	1.49*** (1.12, 1.99)	1.26 (0.93, 1.70)	1.18 (0.86, 1.62)
70+		1.53*** (1.12, 2.08)	1.45** (1.05, 2.01)	0.97 (0.67, 1.38)	0.92 (0.63, 1.34)
Place of residence					
Urban (Ref.)					
Rural		2.39*** (1.68, 3.39)	1.21 (0.83, 1.77)	1.19 (0.80, 1.77)	1.23 (0.83, 1.86)
Marital status					
Currently married (Ref.)					
Not currently married		1.20 (0.86, 1.67)	1.08 (0.77, 1.53)	1.11 (0.77, 1.60)	0.99 (0.67, 1.46)
Schooling (years)					
No schooling (Ref.)					
1–5 years			0.86 (0.64, 1.16)	0.87 (0.63, 1.19)	0.96 (0.69, 1.34)
6–9 years			0.77 (0.53, 1.14)	0.84 (0.56, 1.26)	0.90 (0.58, 1.38)
10+ years			0.95 (0.63, 1.44)	1.18 (0.76, 1.83)	1.45 (0.90, 2.33)

(*Continued*)

Table 5. (*Continued*)

Variable	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)	Model 5 OR (95% CI)
Wealth quintile					
Poorest (Ref.)					
Poor			0.60*** (0.44, 0.81)	0.58*** (0.42, 0.81)	0.65** (0.46, 0.92)
Middle			0.40*** (0.28, 0.57)	0.36*** (0.25, 0.52)	0.41*** (0.28, 0.59)
Richer			0.18*** (0.12, 0.29)	0.19*** (0.12, 0.30)	0.22*** (0.13, 0.35)
Richest			0.07*** (0.04, 0.13)	0.08*** (0.04, 0.14)	0.088*** (0.04, 0.16)
Health marker					
No reported health condition (Ref.)					
High blood pressure				0.95 (0.63, 1.44)	0.94 (0.61, 1.45)
Diabetes				0.98 (0.55, 1.73)	1.09 (0.61, 1.95)
Asthma				1.23 (0.83, 1.80)	1.20 (0.80, 1.80)
Arthritis				0.85 (0.60, 1.2)	0.82 (0.57, 1.17)
Angina				0.92 (0.51, 1.66)	0.97 (0.53, 1.79)
Edentulism				1.43** (1.01, 2.02)	1.48** (1.04, 2.12)
Poor self-rated health				5.16*** (3.92, 6.78)	4.67*** (3.50, 6.25)
BMI					
Underweight				0.94 (0.71, 1.23)	0.84 (0.63, 1.12)
Normal weight (Ref.)					
Overweight				0.57 (0.27, 1.17)	0.58 (0.28, 1.21)
Obese				1.26 (0.47, 3.40)	0.95 (0.26, 3.43)
Grip strength					
1 (Lowest) (Ref.)					
2					1.14 (0.79, 1.65)

(*Continued*)

Table 5. (*Continued*)

Variable	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)	Model 5 OR (95% CI)
3					1.04 (0.70, 1.55)
4					0.88 (0.57, 1.36)
5 (Highest)					0.55** (0.31, 0.98)
Cognitive ability					
1 (Lowest) (Ref.)					
2					1.01 (0.70, 1.46)
3					0.97 (0.65, 1.45)
4					0.94 (0.61, 1.46)
5 (Highest)					0.57* (0.32, 1.04)
Adjusted R^2	0.0129	0.033	0.1075	0.1824	0.176
N	3219	3219	3191	3190	3088

β=coefficient value; CI=confidence interval.
***$p<0.001$; **$p<0.005$; *$p<0.01$.

Table 6. Bivariate and multivariate logistic regression results on the association between height and self-rated poor quality of life among older women in India, WHO-SAGE Wave 1 (2007)

Variable	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)	Model 5 OR (95% CI)
Height quintile					
1 (Lowest) (Ref.)					
2	0.74* (0.54, 1.01)	0.82 (0.60, 1.13)	0.82 (0.59, 1.14)	0.85 (0.6, 1.21)	0.85 (0.58, 1.24)
3	0.65** (0.47, 0.90)	0.77 (0.55, 1.08)	0.79 (0.56, 1.13)	0.79 (0.54, 1.16)	0.81 (0.54, 1.21)
4	0.48*** (0.34, 0.68)	0.58*** (0.40, 0.82)	0.68** (0.47, 0.98)	0.69* (0.46, 1.02)	0.71 (0.46, 1.08)
5 (Highest)	0.39*** (0.27, 0.57)	0.47*** (0.32, 0.68)	0.56*** (0.37, 0.83)	0.62** (0.40, 0.94)	0.64* (0.40, 1.00)
Age					
50–59 (Ref.)					
60–69		0.99 (0.76, 1.30)	0.99 (0.75, 1.30)	0.88 (0.65, 1.19)	0.93 (0.68, 1.28)
70+		1.12 (0.82, 1.53)	1.22 (0.88, 1.69)	0.93 (0.65, 1.34)	0.99 (0.67, 1.47)
Place of residence					
Urban (Ref.)					
Rural		2.05*** (1.53, 2.74)	1.13 (0.82, 1.57)	1.03 (0.73, 1.46)	1.02 (0.71, 1.47)
Marital status					
Currently married (Ref.)					
Not currently married		2.44*** (1.91, 3.12)	2.07*** (1.60, 2.67)	1.96*** (1.49, 2.56)	1.88*** (1.42, 2.50)
Schooling (years)					
No schooling (Ref.)					
1–5 years			1.30 (0.92, 1.84)	1.16 (0.80, 1.69)	1.18 (0.8, 1.76)
6–9 years			0.86 (0.45, 1.61)	0.79 (0.41, 1.53)	0.78 (0.39, 1.53)
10+ years			0.52 (0.18, 1.48)	0.57 (0.19, 1.66)	0.55 (0.18, 1.66)

(*Continued*)

https://doi.org/10.1017/S0021932021000146 Published online by Cambridge University Press

Table 6. (*Continued*)

Variable	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)	Model 5 OR (95% CI)
Wealth quintile					
Poorest (Ref.)					
Poor			0.56*** (0.41, 0.76)	0.56*** (0.40, 0.77)	0.54*** (0.38, 0.76)
Middle			0.29*** (0.20, 0.41)	0.29*** (0.19, 0.41)	0.27*** (0.18, 0.40)
Richer			0.22*** (0.15, 0.32)	0.24*** (0.16, 0.36)	0.21*** (0.13, 0.32)
Richest			0.09*** (0.05, 0.15)	0.10*** (0.05, 0.17)	0.08*** (0.04, 0.15)
Health marker					
No reported health condition (Ref.)					
High blood pressure				1.28 (0.91, 1.79)	1.31 (0.92, 1.87)
Diabetes				1.40 (0.80, 2.43)	1.61 (0.89, 2.90)
Asthma				1.66** (1.04, 2.63)	1.71** (1.02, 2.86)
Arthritis				1.04 (0.77, 1.42)	1.01 (0.72, 1.40)
Angina				1.44 (0.78, 2.65)	1.21 (0.62, 2.34)
Edentulism				0.70* (0.48, 1.01)	0.67* (0.44, 1.00)
Poor SRH				5.15*** (3.99, 6.65)	5.36*** (4.06, 7.06)
BMI					
Underweight				1.33** (1.01, 1.74)	1.37** (1.03, 1.82)
Normal weight (Ref.)					
Overweight				0.95 (0.59, 1.52)	0.89 (0.54, 1.47)
Obese				0.34** (0.12, 0.91)	0.37* (0.13, 1.00)
Handgrip strength					
1 (Lowest) (Ref.)					
2					1.07 (0.74, 1.56)

(*Continued*)

Table 6. (*Continued*)

Variable	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)	Model 5 OR (95% CI)
3					0.98 (0.65, 1.47)
4					1.20 (0.79, 1.81)
5 (Highest)					0.88 (0.53, 1.45)
Cognitive ability					
1 (Lowest) (Ref.)					
2					0.93 (0.63, 1.37)
3					1.25 (0.85, 1.85)
4					1.67** (1.11, 2.52)
5 (Highest)					1.17 (0.69, 2.00)
Adjusted R^2	0.0146	0.0536	0.1243	0.2186	0.2216
Height quintile	3154	3154	3128	3119	2907

β=coefficient value; CI=confidence interval.
***$p<0.001$; **$p<0.005$; *$p<0.01$.

Table 7. Association between height and quality-of-life outcomes (WHO-QoL and self-rated poor quality of life) by age group, WHO-SAGE Wave 1, 2007

	50–59	60–69	70+
	β (95% CI)	β (95% CI)	β (95% CI)
WHO-QoL			
Height quintile			
1 (Lowest) (Ref.)			
2	0.54 (–0.70, 1.78)	1.25* (–0.01, 2.51)	1.15 (–0.52, 2.82)
3	1.37** (0.13, 2.61)	1.10* (–0.19, 2.40)	2.86*** (1.15, 4.56)
4	1.68*** (0.45, 2.91)	1.14* (–0.15, 2.44)	2.68*** (0.86, 4.50)
5 (Highest)	2.17*** (0.93, 3.42)	1.94*** (0.58, 3.31)	2.41** (0.57, 4.25)
Self-rated poor quality of life			
Height quintile	OR (95% CI)	OR (95% CI)	OR (95% CI)
1 (Lowest) (Ref.)			
2	0.88 (0.56, 1.40)	1.05 (0.66, 1.66)	0.64* (0.37, 1.08)
3	0.72 (0.45, 1.15)	0.96 (0.59, 1.57)	0.64 (0.37, 1.11)
4	0.55** (0.33, 0.91)	1.12 (0.68, 1.84)	0.47** (0.24, 0.90)
5 (Highest)	0.81 (0.50, 1.33)	0.92 (0.52, 1.63)	0.38*** (0.18, 0.79)

Regression results adjusted for socio-demographic characteristics, chronic diseases, BMI, poor self-rated health, handgrip strength and cognitive ability.
β=coefficient value; CI=confidence interval.
***$p<0.001$; **$p<0.005$; *$p<0.01$.

subjective well-being in adulthood (Case & Paxson, 2008b; McEniry, 2013), suggesting that childhood nutrition and health affect the well-being of a population throughout the life course.

This study found that handgrip strength and cognitive ability showed a positive relationship with the WHO quality-of-life score, suggesting the importance of muscle strength and cognitive ability in later life. In old age, muscle strength is a potential marker of health and overall well-being; this is supported by several studies, particularly in high-income countries (Giampaoli *et al.*, 1999; Sayer *et al.*, 2006; Gale *et al.*, 2007; Leong *et al.*, 2015; Musalek & Kirchengast, 2017; Celis-Morales *et al.*, 2018). Similarly, the association between cognitive ability and quality of life is consistent with previous findings (Singh *et al.,* 2017).

The association between socioeconomic status and quality of life has been found to be highly significant in India (Alcañiz & Solé-Auró, 2018). In particular, wealth quintile strongly predicts the quality of life of older Indians. These factors, together with handgrip strength, play an important role in mediating the relationship between height and quality-of-life outcome (Deaton & Arora, 2009; Carrieri & De Paola, 2012; Sohn, 2016). Socioeconomic status has been shown to play an important role in determining health and quality of life through nutrition and access to health and social care (Marmot *et al.*, 1991; Nédó & Paulik, 2012; Selvamani & Singh, 2018). Furthermore, marital status is closely linked to quality-of-life outcomes among older women in India. In India, many (nearly half) of women over the age of 50 are widowed, largely as a result of the large age gap at marriage, associated changes in living arrangements and economic factors that can contribute to a decrease in their quality of life (Perkins *et al.,* 2016a). The association of poor self-rated health with WHO-QoL and poor quality of life in this study was highly significant. Self-rated health is an important measure of general health and a strong predictor of future health and mortality (Idler & Benyamini, 1997).

https://doi.org/10.1017/S0021932021000146 Published online by Cambridge University Press

This study found considerable differences in height by socio-demographic characteristics. Age was shown to be negatively associated with the height of older adults, replicating a secular trend in height and living standards found among succeeding cohorts across developed (Silventoinen *et al*., 1999; Onland-Moret *et al*., 2005) and developing countries (Mamidi *et al*., 2011). Age-associated physiological changes, such as declining muscle mass and bone density, have been shown to be significant contributors to height decline in old age (Fernihough & McGovern, 2015). Years of education and wealth quintile have also been shown to be positively associated with height (Silventoinen *et al*., 1999; Mamidi *et al*., 2011), with a suggestion of a bidirectional relationship. Tallness is associated with better socioeconomic achievement through better cognitive abilities and job performance (Vogl, 2014; Kim & Han, 2017). On the other hand, life-course circumstances such as better socioeconomic status predict height through better nutrition and health (Case & Paxson, 2008b; Tucker-Seeley & Subramanian, 2011).

The strengths of this study are twofold. First, most previous studies examining the associations between height, health and quality-of-life outcomes used self-reported height, whereas the present study used objectively measured height. Second, while most previous studies used a single metric to capture well-being, such as a happiness or life satisfaction scale, this study used the WHO's widely accepted composite quality-of-life index. The study's limitations included the data being cross-sectional so no causal relationship could be determined, and that the measures used to construct the WHO-QoL score were based on self-reported data.

In conclusion, this study found adult height to be significantly associated with quality of life among older adults in India, and highlights the long-term effects of early-life conditions on later-life subjective well-being. Shorter height, as a proxy for childhood nutrition/health, showed a significant negative association with self-rated poor quality of life in later life, suggesting that childhood health and nutrition play an important role in determining health and well-being in later life. An understanding of the well-being of the growing older population must therefore consider the role of early-life conditions. Improvement in early-life conditions, such as childhood nutrition, is important for well-being across the life course. The study also observed significant socioeconomic differentials in quality of life and height in older adults India, suggesting a role for socioeconomic status in overall well-being in later life in developing countries. The role of handgrip strength and cognitive ability in predicting quality of life highlight the importance of physical and mental capacity in later life.

Acknowledgments. The authors are grateful to WHO-SAGE for providing access to data. The SAGE survey was supported by the World Health Organization, Division of Behavioral and Social Research at the National Institute on Aging and US Agency for International Development (USAID) in New Delhi.

Funding. This research received no specific grant from any funding agency, commercial entity or not-for-profit organization.

Conflicts of Interest. The authors report no conflicts of interest.

Ethical Approval. This study used the secondary data collected by the WHO in collaboration with country research organizations. The SAGE study was approved by the Ethics Review Committee, WHO, Geneva, Switzerland and the Institutional Review Board, International Institute of Population Sciences, Mumbai, India. Informed written consent was obtained from each participant, who were reassured that data would remain confidential and used for research purposes only.

References

Aartsen MJ, Cheval B, Sieber S, Van der Linden BW, Gabriel R, Courvoisier DS *et al.* (2019) Advantaged socioeconomic conditions in childhood are associated with higher cognitive functioning but stronger cognitive decline in older age. *Proceedings of the National Academy of Sciences of the USA* **116**(12), 5478–5486.

Agarwal A, Lubet A, Mitgang E, Mohanty S and Bloom DE (2020) Population aging in India: facts, issues, and options. In Poot J and Roskruge M (eds) *Population Change and Impacts in Asia and the Pacific*. Springer, Singapore, pp. 289–311.

Alcañiz M and Solé-Auró A (2018) Feeling good in old age: factors explaining health-related quality of life. *Health and Quality of Life Outcomes* **16**(1), 48.

https://doi.org/10.1017/S0021932021000146 Published online by Cambridge University Press

Arokiasamy P and Selvamani Y (2018) Age, socioeconomic patterns and regional variations in grip strength among older adults (50+) in India: evidence from WHO's Study on Global Ageing and Adult Health (SAGE). *Archives of Gerontology and Geriatrics* **76**, 100–105.

Arokiasamy P, Uttamacharya U, Jain K, Biritwum RB, Yawson AE, Wu F *et al.* (2015) The impact of multimorbidity on adult physical and mental health in low-and middle-income countries: what does the study on global ageing and adult health (SAGE) reveal? *BMC Medicine* **13**(1), 178.

Arokiasamy P, Uttamacharya, Kowal P and Chatterji S (2016) Age and socioeconomic gradients of health of Indian adults: an assessment of self-reported and biological measures of health. *Journal of Cross-Cultural Gerontology* **31**(2), 193–211.

Banjare P, Dwivedi R and Pradhan J (2015) Factors associated with the life satisfaction amongst the rural elderly in Odisha, India. *Health and Quality of Life Outcomes* **13**(1), 201.

Batty GD, Deary IJ and Zaninotto P (2016) Association of cognitive function with cause-specific mortality in middle and older age: follow-up of participants in the English longitudinal study of ageing. *American Journal of Epidemiology* **183**(3), 183–190.

Batty GD, Shipley MJ, Gunnell D, Huxley R, Kivimaki M, Woodward M *et al.* (2009) Height, wealth, and health: an overview with new data from three longitudinal studies. *Economics & Human Biology* **7**(2), 137–152.

Bhan N, Rao N and Raj A (2020) Gender differences in the associations between informal caregiving and wellbeing in low- and middle-income countries. *Journal of Women's Health* **29**(10), 1328–1338.

Bozzoli C, Deaton A and Quintana-Domeque C (2009) Adult height and childhood disease. *Demography* **46**(4), 647–669.

Carrieri V and De Paola M (2012) Height and subjective well-being in Italy. *Economics & Human Biology* **10**(3), 289–298.

Case A and Paxson C (2008a) Height, health, and cognitive function at older ages. *American Economic Review* **98**(2), 463–467.

Case A and Paxson C (2008b) Stature and status: height, ability, and labor market outcomes. *Journal of Political Economy* **116**(3), 499–532.

Case A and Paxson C (2010) Causes and consequences of early-life health. *Demography* **47**(1), S65–S85.

Celis-Morales CA, Welsh P, Lyall DM, Steell L, Petermann F, Anderson J *et al.* (2018) Associations of grip strength with cardiovascular, respiratory, and cancer outcomes and all cause mortality: prospective cohort study of half a million UK Biobank participants. *BMJ* **361**, doi: https://doi.org/10.1136/bmj.k1651.

Census of India (2011) *Office of the Registrar General and Census Commissioner*. URL: http://www.censusindia.gov.in/vital_statistics/srs_report/9chap%202%20-%202011.pdf (accessed 25th August 2020).

Chatterji S, Kowal P, Mathers C, Naidoo N, Verdes E, Smith JP and Suzman R (2008) The health of aging populations in China and India. *Health Affairs* **27**(4), 1052–1063.

Chen C (2001) Aging and life satisfaction. *Social Indicators Research* **54**(1), 57–79.

Cheval B, Boisgontier MP, Orsholits D, Sieber S, Guessous I, Gabriel R *et al.* (2018) Association of early- and adult-life socioeconomic circumstances with muscle strength in older age. *Age and Ageing* **47**(3), 398–407.

Cinnirella F, Piopiunik M and Winter J (2011) Why does height matter for educational attainment? Evidence from German children. *Economics & Human Biology* **9**(4), 407–418.

Coste J, Pouchot J and Carel JC (2012) Height and health-related quality of life: a nationwide population study. *Journal of Clinical Endocrinology & Metabolism* **97**(9), 3231–3239.

Currie J and Vogl T (2013) Early-life health and adult circumstance in developing countries. *Annual Review of Economics* **5**(1), 1–36.

Deaton A and Arora R (2009) Life at the top: the benefits of height. *Economics & Human Biology* **7**(2), 133–136.

Denny K (2017) Are the effects of height on well-being a tall tale? *Journal of Happiness Studies* **18**(5), 1445–1458.

Emami E, de Souza RF, Kabawat M and Feine JS (2013) The impact of edentulism on oral and general health. *International Journal of Dentistry*, doi: 10.1155/2013/498305.

Fernihough A and McGovern ME (2015) Physical stature decline and the health status of the elderly population in England. *Economics & Human Biology* **16**, 30–44.

Fujiwara T, Kondo K, Shirai K, Suzuki K and Kawachi I (2014) Associations of childhood socioeconomic status and adulthood height with functional limitations among Japanese older people: results from the JAGES 2010 Project. *Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences* **69**(7), 852–859.

Gale CR, Martyn CN, Cooper C and Sayer AA (2007) Grip strength, body composition, and mortality. *International Journal of Epidemiology* **36**(1), 228–235.

Giampaoli S, Ferrucci L, Cecchi F, Lo Noce C, Poce A, Dima F *et al.* (1999) Hand-grip strength predicts incident disability in non-disabled older men. *Age and Ageing* **28**(3), 283–288.

Gottfredson LS and Deary IJ (2004) Intelligence predicts health and longevity, but why? *Current Directions in Psychological Science* **13**(1), 1–4.

Greenfield EA and Moorman SM (2019) Childhood socioeconomic status and later life cognition: evidence from the Wisconsin Longitudinal Study. *Journal of Aging and Health* **31**(9), 1589–1615.

Guven C and Lee WS (2013) Height and cognitive function at older ages: is height a useful summary measure of early childhood experiences? *Health Economics* **22**(2), 224–233.

Guven C and Lee WS (2015) Height, aging and cognitive abilities across Europe. *Economics & Human Biology* **16**, 16–29.
Howel D (2012) Interpreting and evaluating the CASP-19 quality of life measure in older people. *Age and Ageing* **41**(5), 612–617.
Ibragimova N and Salahodjaev R (2020) Does height matter for earnings? *Evidence from Russia. Journal of Biosocial Science* **52**(6), 885–894.
Idler EL and Benyamini Y (1997) Self-rated health and mortality: a review of twenty-seven community studies. *Journal of Health and Social Behavior* **38**(1), 21–37.
Ihira H, Sawada N, Iwasaki M, Yamaji T, Goto A, Noda M *et al.* (2018) Adult height and all-cause and cause-specific mortality in the Japan Public Health Center-based Prospective Study (JPHC). *PloS One* **13**(5), e0197164.
Ingle GK and Nath A (2008) Geriatric health in India: concerns and solutions. *Indian Journal of Community Medicine* **33**(4), 214.
Kim TH and Han E (2017) Height premium for job performance. *Economics & Human Biology* **26**, 13–20.
Kobayashi LC, Berkman LF, Wagner RG, Kahn K, Tollman S and Subramanian SV (2019) Education modifies the relationship between height and cognitive function in a cross-sectional population-based study of older adults in rural South Africa. *European Journal of Epidemiology* **34**(2), 131–139.
Kojima G, Iliffe S, Jivraj S and Walters K (2016) Association between frailty and quality of life among community-dwelling older people: a systematic review and meta-analysis. *Journal of Epidemiology Community Health* **70**(7), 716–721.
Kowal P, Chatterji S, Naidoo N, Biritwum R, Fan W, Lopez Ridaura R *et al.* (2012) Data resource profile: the World Health Organization Study on global AGEing and adult health (SAGE). *International Journal of Epidemiology* **41**(6), 1639–1649.
Kuruvilla S, Sadana R, Montesinos EV, Beard J, Vasdeki JF, de Carvalho IA *et al.* (2018) A life-course approach to health: synergy with sustainable development goals. *Bulletin of the World Health Organization* **96**(1), 42–50.
LaFave D and Thomas D (2017) Height and cognition at work: labor market productivity in a low income setting. *Economics & Human Biology* **25**, 52–64.
Layte R, Sexton E and Savva G (2013) Quality of life in older age: evidence from an Irish cohort study. *Journal of the American Geriatrics Society* **61**, S299–S305.
Lee J, Shih R, Feeney K and Langa KM (2014) Gender disparity in late-life cognitive functioning in India: findings from the longitudinal aging study in India. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences* **69**(4), 603–611.
Lee WS and Zhao Z (2017) Height, weight and well-being for rural, urban and migrant workers in China. *Social Indicators Research* **132**(1), 117–136.
Leong DP, Teo KK, Rangarajan S, Lopez-Jaramillo P, Avezum Jr A, Orlandini A *et al.* (2015) Prognostic value of grip strength: findings from the Prospective Urban Rural Epidemiology (PURE) study. *The Lancet* **386**(9990), 266–273.
Lezak MD, Howieson DB, Loring DW and Fischer JS (2004) *Neuropsychological Assessment*. Oxford University Press.
Lundborg P, Nystedt P and Rooth DO (2009) The height premium in Earnings: the role of physical capacity and cognitive and non-cognitive skills. *IDA Discussion Paper 4266*. IZA: Bonn, Germany.
McEniry M (2013) Early-life conditions and older adult health in low-and middle-income countries: a review. *Journal of Developmental Origins of Health And Disease* **4**(1), 10.
McGovern ME (2014) Comparing the relationship between stature and later life health in six low and middle income countries. *Journal of the Economics of Ageing* **4**, 128–148.
McGuire LC, Ford ES and Ajani UA (2006) Cognitive functioning as a predictor of functional disability in later life. *American Journal of Geriatric Psychiatry* **14**(1), 36–42.
Mamidi RS, Kulkarni B and Singh A (2011) Secular trends in height in different states of India in relation to socioeconomic characteristics and dietary intakes. *Food and Nutrition Bulletin* **32**(1), 23–34.
Marmot MG, Stansfeld S, Patel C, North F, Head J, White I *et al.* (1991) Health inequalities among British civil servants: the Whitehall II study. *The Lancet* **337**(8754), 1387–1393.
Moeini B, Barati M, Farhadian M and Ara MH (2018) The association between social support and happiness among elderly in Iran. *Korean Journal of Family Medicine* **39**(4), 260.
Murasko JE (2019) Sorting by height: education and economic outcomes of women in less-developed countries. *Journal of Development Studies* **55**(11), 2347–2364.
Murasko JE (2020) Height, marriage, and partner characteristics for women in low-and middle-income countries. *Economics & Human Biology* **38**, 100876.
Musalek C and Kirchengast S (2017) Grip strength as an indicator of health-related quality of life in old age – a pilot study. *International Journal of Environmental Research and Public Health* **14**(12), 1447.
Nédó E and Paulik E (2012) Association of smoking, physical activity, and dietary habits with socioeconomic variables: a cross-sectional study in adults on both sides of the Hungarian-Romanian border. *BMC Public Health* **12**(1), 60.
Newman AB, Kupelian V, Visser M, Simonsick EM, Goodpaster BH, Kritchevsky SB *et al.* (2006) Strength, but not muscle mass, is associated with mortality in the health, aging and body composition study cohort. *Journals of Gerontology Series A: Biological Sciences and Medical Sciences* **61**(1), 72–77.
Ng ST, Tey NP and Asadullah MN (2017) What matters for life satisfaction among the oldest-old? Evidence from China. *PloS One* **12**(2), e0171799.
Onland-Moret NC, Peeters PHM, Van Gils CH, Clavel-Chapelon F, Key T, Tjønneland A *et al.* (2005) Age at menarche in relation to adult height: the EPIC study. *American Journal of Epidemiology* **162**(7), 623–632.

Öztürk A, Şimşek TT, Yümin ET, Sertel M and Yümin M (2011) The relationship between physical, functional capacity and quality of life (QoL) among elderly people with a chronic disease. *Archives of Gerontology and Geriatrics* **53**(3), 278–283.
Patel PC and Devaraj S (2018) Height–income association in developing countries: evidence from 14 countries. *American Journal of Human Biology* **30**(3), e23093.
Peck AM and Vågerö DH (1989) Adult body height, self perceived health and mortality in the Swedish population. *Journal of Epidemiology & Community Health* **43**(4), 380–384.
Perkins JM, Lee HY, James KS, Oh J, Krishna A, Heo J *et al.* (2016a) Marital status, widowhood duration, gender and health outcomes: a cross-sectional study among older adults in India. *BMC Public Health* **16**(1), 1032.
Perkins JM, Subramanian SV, Davey Smith G and Özaltin E (2016b) Adult height, nutrition, and population health. *Nutrition Reviews* **74**(3), 149–165.
Raggi A, Corso B, Minicuci N, Quintas R, Sattin D, De Torres L *et al.* (2016) Determinants of quality of life in ageing populations: results from a cross-sectional study in Finland, Poland and Spain. *PLoS One* **11**(7), e0159293.
Rees DI, Sabia JJ and Argys LM (2009) A head above the rest: height and adolescent psychological well-being. *Economics & Human Biology* **7**(2), 217–228.
Sayer AA, Syddall HE, Martin HJ, Dennison EM, Roberts HC and Cooper C (2006) Is grip strength associated with health-related quality of life? Findings from the Hertfordshire Cohort Study. *Age and Ageing* **35**(4), 409–415.
Schmidt S, Mühlan H and Power M (2006) The EUROHIS-QOL 8-item index: psychometric results of a cross-cultural field study. *European Journal of Public Health* **16**(4), 420–428.
Selvamani Y and Singh P (2018) Socioeconomic patterns of underweight and its association with self-rated health, cognition and quality of life among older adults in India. *PLoS One* **13**(3), e0193979.
Silventoinen K (2003) Determinants of variation in adult body height. *Journal of Biosocial Science* **35**(2), 263.
Silventoinen K, Lahelma E and Rahkonen O (1999) Social background, adult body-height and health. *International Journal of Epidemiology* **28**(5), 911–918.
Singh P, Govil D, Kumar V and Kumar J (2017) Cognitive impairment and quality of life among elderly in India. *Applied Research in Quality of Life* **12**(4), 963–979.
Sohn K (2016) Height and happiness in a developing country. *Journal of Happiness Studies* **17**(1), 1–23.
Srivastava A and Mohanty SK (2012) Poverty among elderly in India. *Social Indicators Research* **109**(3), 493–514.
Steptoe A and Zaninotto P (2020) Lower socioeconomic status and the acceleration of aging: an outcome-wide analysis. *Proceedings of the National Academy of Sciences of the USA* **117**(26), 14911–14917.
Strauss J and Thomas D (1998) Health, nutrition, and economic development. *Journal of Economic Literature* **36**(2), 766–817.
Tucker-Seeley RD and Subramanian SV (2011) Childhood circumstances and height among older adults in the United States. *Economics & Human Biology* **9**(2), 194–202.
Ugargol AP and Bailey A (2018) Family caregiving for older adults: gendered roles and caregiver burden in emigrant households of Kerala, India. *Asian Population Studies* **14**(2), 194–210.
Ugargol AP, Hutter I, James KS and Bailey A (2016) Care needs and caregivers: associations and effects of living arrangements on caregiving to older adults in India. *Ageing International* **41**(2), 193–213.
United Nations (2015) *World Population Ageing*. United Nations Department of Economics and Social Affairs. URL: https://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015_Report.pdf
Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L *et al.* (2008) Maternal and child undernutrition: consequences for adult health and human capital. *The Lancet* **371**(9609), 340–357.
Vogl TS (2014) Height, skills, and labor market outcomes in Mexico. *Journal of Development Economics* **107**, 84–96.
Vyas S and Kumaranayake L (2006) Constructing socio-economic status indices: how to use principal components analysis. *Health Policy and Planning* **21**(6), 459–468.
WHOQoL Group (1993) Study protocol for the World Health Organization project to develop a Quality of Life assessment instrument (WHOQOL). *Quality of Life Research* **2**(2), 153–159.

Cite this article: Selvamani Y and Arokiasamy P (2022). Height and quality of life among older adults (50+) in India: a cross-sectional study. *Journal of Biosocial Science* **54**, 411–436. https://doi.org/10.1017/S0021932021000146