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PII:	S0531-5565(18)30179-7
DOI:	doi:10.1016/j.exger.2018.09.026
Reference:	EXG 10462
To appear in:	*Experimental Gerontology*
Received date:	15 March 2018
Revised date:	6 September 2018
Accepted date:	30 September 2018

Please cite this article as: Claudia Troncoso, Fanny Petermann, Rosemary Brown, Ana María Leiva, María Adela Martinez, Ximena Diaz-Martinez, Alex Garrido-Mendez, Felipe Poblete-Valderrama, José A. Iturra-Gonzalez, Marcelo Villagran, Lorena Mardones, Carlos Salas-Bravo, Natalia Ulloa, Antonio Garcia-Hermoso, Robinson Ramírez-Vélez, Jaime Vásquez Gómez, Carlos Celis-Morales , Patterns of healthy lifestyle behaviours in older adults: Findings from the Chilean National Health Survey 2009–2010. Exg (2018), doi:10.1016/j.exger.2018.09.026

PATTERNS OF HEALTHY LIFESTYLE BEHAVIOURS IN OLDER ADULTS: FINDINGS FROM THE CHILEAN NATIONAL HEALTH SURVEY 2009-2010

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Abbreviated title: Healthy lifestyle behaviours in older adults

Declarations of interest

None

Word count:

Number of Tables: 1

Number of Figures: 1

ABSTRACT

The purpose of this study was to investigate healthy lifestyle behaviours across age categories in the older population in Chile. Data from 1,390 older adults (≥60 years), in the 2009-2010 Chilean National Health Survey were analyzed. We derived the following age categories: 60-65, 66-70, 71-75, 76-80 and >80 years. The association between age and compliance with healthy lifestyle behaviours (smoking, sitting time, physical activity, sleep duration and intake of salt, alcohol, fruit and vegetables) were investigated using logistic regression. The probability of meeting the guidelines for alcohol intake (OR trend: 1.35 [95% CI: 1.11; 1.64], p=0.001) and smoking (OR trend: 1.23 [95% CI: 1.13; 1.33], p<0.0001) increased with age, whereas spending <4 hours per day sitting time or engaging in at least 150 minutes of physical activity per week or sleep on average between 7 and 9 hours per day were less likely to be met with increasing age (OR trend: 0.77 [95% CI: 0.71; 0.83], p<0.000; OR trend: 0.73 [95% CI: 0.67; 0.79], p<0.0001, and OR trend: 0.89 [95% CI: 0.82; 0.96], p=0.002, respectively). No significant trend across age categories was observed for fruit and vegetables, and salt intake. The probability of meeting at least 3 out of 7 healthy lifestyle behaviours across the age categories was also lower in older age categories compared to those aged 60 to 65 years. Overall, in older adults the probability of having the healthy lifestyle behaviours of physical activity, sitting time and sleeping behaviours was low but not for smoking or alcohol consumption. With an increasingly ageing population, these findings could inform stakeholders on which lifestyle behaviours could be targeted in the older adults and therefore which interventions should take place to promote healthy ageing.

Key words: Ageing; Lifestyle; Diet; Physical activity; Sedentary behavior; Sleep

Highlights

• The proportion of the older population in Chile has increased from 6.6% in 1992 to 11.4% in 2017.

• The probability of meeting the guidelines for alcohol intake and smoking increases with age

• Chilean older adults were less likely to meet some healthy lifestyle guidelines such as performing 150 minutes of physical activity per week, spending less than 4 hours per day sitting, or sleeping on average between 7 and 9 hours per day.

• The odds of meeting at least 3 out of 7 healthy lifestyle behaviours was also lower with increasing age.

1. Introduction

The major demographic shift towards a higher proportion of older adults within the population of many countries, and the health and social care cost associated with ageing, makes ageing-research a public health priority (WHO 2017a). The World Health Organization has projected that by 2050 the population aged 60 years and older will increase to 2 billion individuals, which is equivalent to one-fifth of the population worldwide (WHO 2017a). However, low- and middle-income countries will experience the greatest increase in the number of older adults.

Chile is one of the middle-income countries that is expected to experience an important shift towards population ageing. In the last 25 years, the proportion of older population in Chile has increased from 6.6% in 1992 to 11.4% in 2017 (WHO 2017a), however by the middle of the century the proportion of older adults in Chile will be similar to Japan, a country with one of the largest proportions of older population in the world (WHO 2017a). Although Chile has already developed different actions and public health policies to improve the condition of, and quality of lifein, older adults such as an active ageing programme (Guevara 2016), little is known with regard to how the Chilean population is ageing and what the main social and economic consequences of this population transition will be. Moreover, there is a lack of evidence regarding the adherence to healthy lifestyle behaviours in the Chilean older population.

Since lifestyle factors play a key role in promoting and maintaining health and wellbeing as we age (Sodergren and others 2014; WHO 2015a), increasing our understanding of how adherence to healthy lifestyle behaviours changes across different age categories during older age could be important for informing stakeholders on which lifestyle factors should be promoted through public health policies and intervention programmes. Therefore, the aim of this study was to investigate healthy lifestyle behaviours across age categories in the older population of Chile.

2. Materials and methods

2.1 Study design

The Chilean National Health Survey (CNHS) is a large, nationally representative population-based study of biological and lifestyle risk factors, dietary status and health, conducted every six years in Chile (MINSAL 2009). Complex random stratified sampling was used to recruit 5,293 individuals as a nationally representative sample based on statistics from the 2002 Chilean National Census, which included strata from administrative regions (county), sex and urban/rural locations, as described in detail elsewhere (MINSAL 2009). The CNHS 2009-2010 response rate from the eligible population was 85% (5,293 out of 6,100 individuals accepted the invitation to take part in the study). However, a subset of participants aged ≥60 years from the 2009-2010 Chilean National Health Survey (CNHS) was included in this cross-sectional study (n=1,390 participants).

The CNHS was funded by the Chilean Ministry of Health and led by the Department of Public Health, The Pontificia Universidad Católica de Chile. The CNHS was approved by the Ethics Research Committee of the Faculty of Medicine at the Pontificia Universidad Católica de Chile (Application reference number 09-113). All participants who participated in the CNHS provided written informed consent.

2.2 Data sources

Data collection was via face-to-face interviews by trained interviewers, using a validated questionnaire. The preferred respondent for the household socio-demographics was the reported head of household, followed by their spouse or an adult household member. For questions on health status and health outcomes, all household members of 15 years of age or older were asked to complete the questionnaire individually.

2.3 Socio-demographic characteristics

Socio-demographic data were collected for all participants using nationally validated questionnaires, and included age, sex, education level (primary, secondary or beyond secondary) and monthly household income (≤US $480 (lowest), US $480–1250 (middle) and >US $1250 (highest)). Following the World Health Organization recommendations, older adults were considered allparticipants aged ≥60 years. For the purposes of this study, individuals were then grouped into five age categories (60-65, 66-70, 71-75, 76-80 and >80 years).

2.4 Anthropometric measures

Height was measured to the nearest 0.1 cm using a portable stadiometer and weight was measured to the nearest 0.1 kg using a digital scale (Tanita HD313) with participants removing their shoes and wearing light clothing. Body mass index (BMI) was calculated as weight/height^2 and classified using the World Health Organization criteria for older adults **(**underweight: <22,9 kg/m^2; normal: 23.0 to 27.9 kg/m^2; overweight: 28.0 to 31.9 kg/m^2; obese: ≥32 kg/m^2) (PAHO 2003). Waist and hip circumference (WC) was measured using standardised protocols. Central obesity was defined as waist circumference >88 cm for women and >102 cm for men (MINSAL 2010). Waist to hip ratio (WHR) was derived and the WHO cut-off point was used to define obesity (WHR >0.90 for men and >0.85 for women) (WHO 2008).

2.5 Lifestyle behaviours

Physical activity level, including moderate and vigorous intensities and transport-related physical activity, were measured using the Global Physical Activity Questionnaire version 2 (QPAQ v2)(WHO 2009). Physical activity was

categorised into: inactive individuals (<600 MET/min/week) and active individuals (≥600 MET/min/week) (IPAQ 2004). Sedentary behaviour was derived using the following question: 'How much time do you usually spend sitting or reclining on a typical day?' (WHO 2009). Participants were then classified as having low or high sitting behaviour using the population median as the cut-off point (4 hours/day) (Celis-Morales and others 2015b). The GPAQ has been previously validated in the Chilean population, showing a moderate agreement with objectively measured physical activity data (Aguilar-Farias and Leppe Zamora 2016).

Sleep duration was collected through questionnaires where participants were asked "in a normal day how many hours do you sleep?" This variable was then categorised into normal sleepers (sleep duration between 7 to 9 hours/day) and as abnormal sleepers (including short sleepers <7 hours/day and longer sleepers >9 hours/day) as suggested in previous observational studies (Celis-Morales and others 2017; Gallicchio and Kalesan 2009).

Smoking behaviour was collected using a self-reported questionnaire where participants classified themselves as current smokers, ex-smokers or non-smokers (PAHO 2012). Daily salt intake was determined through sodium levels in a urine sample collected by trained nurses using a standardised protocol. To calculate the 24-hour excreted sodium from urine, a conversion formula by Tanaka et al., which has been previously validated (Tanaka and others 2002), was used. Alcohol consumption was self-reported and collected using the "Alcohol Use Disorders Identification Test" (AUDIT) questionnaire developed by the World Health Organization (Saunders and others 1993b) and adapted for use in Chile (Alvarado and others 2009). The "units of alcohol" indicator represented the number of self-reported 200 ml glasses of alcohol consumed. This was a standard measure adapted from one of the 10 items of the AUDIT questionnaire and an AUDIT score >8 was used as cutoff point for hazardous consumption (Saunders and others 1993b). Dietary intake of fruit and vegetables (F&V) was self-reported and participants were asked "In a typical/ordinary week, how many days do you eat fruit?" and "In a typical/ordinary week, how many days do you eat vegetables?" This was then converted to grams and ≥400 g/day was used as cut-off point for healthy intake (MINSAL 2010).

2.6 Healthy lifestyle index

Based on data on the data collected by the CNHS, seven lifestyle behaviours were used to derive a healthy lifestyle index score including the following cut-off points: a) consumption of ≥5 portions of fruit and vegetables per day; b) salt intake <8 g/day (WHO 2015b); c) alcohol intake <8 AUDIT score points (Santis and others 2009; Saunders and others 1993a); d) self-reported sleeping time between 7 to 9 hours/day; e) smoking (being a non-smoker); f) physical activity >600 MET/min/week; and g) sedentary behaviour <4 hours per day. Individuals who meet these healthy recommendations were given 1 point for each recommendation met whereas those who did not follow them were

assigned 0 points. The maximum possible score was 7 points which represented a healthy lifestyle behaviour score. In addition, and only for the purpose of this study, individuals were classified as having a healthy lifestyle if they scored ≥4 points and an unhealthy lifestyle if they score ≤3 points.

2.7 Statistical Analyses

Statistical analyses were conducted in STATA 14 (StataCorp; College Station, TX) using survey-weighted values. Descriptive characteristics are presented as means and standard deviations (SD) for continuous variables and as percentages for categorical variables by age categories (60-65, 66-70, 71-75, 76-80 and >80 years).

Logistic regression analysis was performed to investigate the odds of meeting each of the healthy lifestyle recommendations by age categories and results were presented as odds ratio (OR) and its respective 95% confidence intervals (95%CI). Those individuals aged 60 to 65 years were used as a reference group. Individuals who met the lifestyle recommendations (consumption of five portions of fruit and vegetables, salt intake lower <8 g/day, alcohol intake with an AUDIT score <8 points, average sleeping time between 7-9 hours/day, non-smokers, physically active (>600 MET/min/week) and sitting time <4 hour/day) were coded as 1 whereas those who did not meet these recommendations were coded as 0. In this context, an OR <1 would represent a lower probability of meeting the healthy lifestyle recommendations and an OR >1 would represent a higher probability of meeting the recommendation. Odds ratios for trend were estimated by coding the age categories in an ordinal manner (i.e. 0, 1, 2, 3 and 4), therefore the OR for trend represents the odds of meeting the healthy lifestyle behaviour by one age category increase. All analyses were adjusted for sex, residence zone (urban, rural), education, gross income and BMI. A p-value <0.05 was considered statistically significant in all analyses.

3. Results

The main participant's characteristics by age categories are summarised in Table 1. Briefly, a higher proportion of women and individuals with lower education level and monthly household income were predominant characteristics among older age groups. Body weight, height, BMI, WC and WHR showed a trend to be lower with increasing age. Similarly, the proportion of underweight individuals increases in the older age categories compared to the youngest one. Physical activity related behaviour shows a decreasing trend with increasing age, whereas sitting time was higher in older ages compared to the younger categories. The prevalence of physical inactivity was 30.5% in the youngest age category but increased to 60.9% in those individuals aged 80 years and above. The proportion of individuals who

reported never smoking was higher in older age compared to the youngest age categories. There were no clear differences for alcohol, salt, or fruit and vegetable, consumption across age categories (Table 1).

Table 1. Cohort characteristics by age categories in older adults

	Age categories				
	60-65	**66-70**	**71-75**	**76-80**	**>80**
Socio-demographic					
Total, n	441	318	235	203	193
Age (years), mean (SD)	62.3 (1.7)	67.8 (1,4)	72.9 (1.5)	77.9 (1.4)	85.0 (4.1)
Sex, (female %)	263 (59.6)	192 (60.4)	131 (55.7)	125 (61.6)	135 (70.0)
Education level (n, %)					
Up to primary (< 8 years)	225 (51.7)	187 (58.8)	155 (67.9)	152 (75.6)	144 (76.2)
Up to secondary (< 12 years)	165 (37.9)	104 (32.7)	59 (25.9)	44 (21.9)	38 (20.1)
Beyond secondary	45 (10.3)	27 (8.5)	14 (6.1)	5 (2.5)	7 (3.7)
Income (n, %)					
Low	264 (62.3)	208 (67.5)	164 (75.6)	154 (78.6)	152 (82.2)
Middle	132 (31.1)	74 (24.0)	41 (18.9)	41 (20.9)	28 (15.1)
High	28 (6.6)	26 (8.4)	12 (5.5)	1 (0.5)	5 (2.7)
Anthropometric					
Body weight (kg)	72.1 (2.9)	71.8 (14.5)	70.9 (14.0)	68.8 (16,1)	61.7 (12.3)
Height (m)	1.57 (0.1)	1.56 (0.1)	1.58 (0.1)	1.54 (0,1)	1.53 (0.1)
BMI (kg/m^2)	29.1 (5.6)	29.1 (5.3)	28.6 (5.1)	28.6 (5,6)	26.2 (4.6)
BMI categories (n, %)*					
Underweight (<22,9 kg/m^2)	149 (8.5)	102 (9.9)	80 (11.3)	59 (12.8)	56 (22.4)
Normal (23.0-27.9 kg/m^2)	121 (34.3)	80 (32.7)	63 (34.6)	47 (30.1)	40 (29.2)
Overweight (28.0-31-9 kg/m^2)	128 (27.8)	99 (25.6)	62 (27.3)	65 (24.0)	53 (20.8)
Obese (≥32.0 kg/m^2)	37 (29.4)	31 (31.7)	26 (26.8)	25 (33.1)	43 (27.6)
WC (cm), mean (SD)	96.1 (11.3)	95.9 (12.8)	95.6 (13.1)	96.9 (13.6)	91.5 (11.2)
Central obesity, n (%)	236 (53.5)	168 (52.8)	128 (54.5)	118 (58.1)	92 (47.7)
WHR , mean (SD)	0.96 (0.07)	0.95 (0.09)	0.96 (0.08)	0.96 (0.08)	0.94 (0.08)
Obesity based on WHR	424 (96.2)	291 (91.5)	225 (95.7)	192 (94.5)	177 (91.7)
Lifestyle					
Total physical activity (MET/h/week), mean (SD)	93.2 (125.9)	92.7 (118.8)	59.9 (84.7)	54.7 (88.2)	30.9 (65.6)
Transport physical activity(min/day), mean (SD)	34.1 (55.8)	43.9 (71.9)	36.2 (68.4)	35.8 (85.4)	30.9 (65.6)
Moderate PA (min/day), mean (SD)	86.7 (132.1)	80.1 (120.8)	71.4 (119.3)	52.9 (97.7)	31.4 (76.1)
Vigorous PA (min/day), mean (SD)	39.5 (105.2)	37.4 (98.1)	10.4 (47.4)	14.2 (52.1)	7.6 (34.7)
Physical inactivity, n (%)	131 (30.5)	83 (26.4)	86 (36.9)	93 (47.2)	114 (60.9)

Sitting time (h/day)	3.2 (2,6)	3.3 (2.4)	3.3 (2.4)	3.8 (2.7)	4.8 (3.1)
F&V intake (g/day), mean (SD)	229.9 (142.9)	230.8 (150.6)	230.9 (147.3)	223.8 (141.1)	208.9 (124.4)
Salt intake (g/day), mean (SD)	9.9 (2.4)	9.7 (2.3)	10.6 (5.6)	10.6 (4.1)	10.2 (4.1)
Alcohol intake (g/day), mean (SD)	42.3 (61.8)	46.5 (2.3)	32.4 (32.4)	49.7 (79.5)	25.8 (20.8)
Smoking status, n (%)					
Never	197 (45.2)	143 (45.1)	138 (60.3)	124 (62.0)	118 (61.5)
Ex-smoker	128 (29.4)	115 (36.3)	70 (30.6)	65 (32.5)	63 (32.8)
Current smoker	111 (25.4)	59 (18.6)	21 (9.1)	11 (5.5)	11 (5.7)

*Data presented as mean and SD for continuous variables or n and % for categorical variables. *Older adult BMI categories*. Central obesity was defined using waist circumference (>102 for men and >88cm for women) and WHR-obesity was defined using waist to hip ratio (>0.90 for men and >0.85 for women).

BMI: body mass index; N: numbers; SD: standard deviation; PA: physical activity; g: grams; min: minutes; h: hours; kg: kilograms; m: metres; WC: waist circumference; whr: waist to hip ratio.

The probability of meeting healthy lifestyle recommendations for alcohol consumption (AUDIT score <8 points) and being a non-smoker increased with increasing age as shown in Figure 1. The odds of meeting these guidelines increase by 35% (OR trend: 1.35 [95% CI: 1.11; 1.64], p=0.001) and 23% (OR trend: 1.23 [95% CI: 1.13; 1.33], p<0.0001) per 5-year age increment, respectively. However, for normal sleep duration (7-9 hours), there was an 11% decrease in the probability of meeting these guidelines with increasing age (OR trend: 0.89 [95% CI: 0.82; 0.96], p=0.002). Similarly, the odds of being physically active decreased by 27% with increasing age (OR trend: 0.73 [95% CI: 0.67; 0.79], p<0.0001), whereas spending less than 4 hours a day sitting was 23% less likely in older ages compared to the reference group (OR trend: 0.77 [95% CI: 0.71; 0.83], p<0.0001). Overall, for every 5 year increment in age, individuals were 22% less likely to achieve the healthy behaviour guidelines (meeting 4 or more healthy behaviours) (OR trend: 0.78 [95% CI: 0.71; 0.85], p<0.0001).

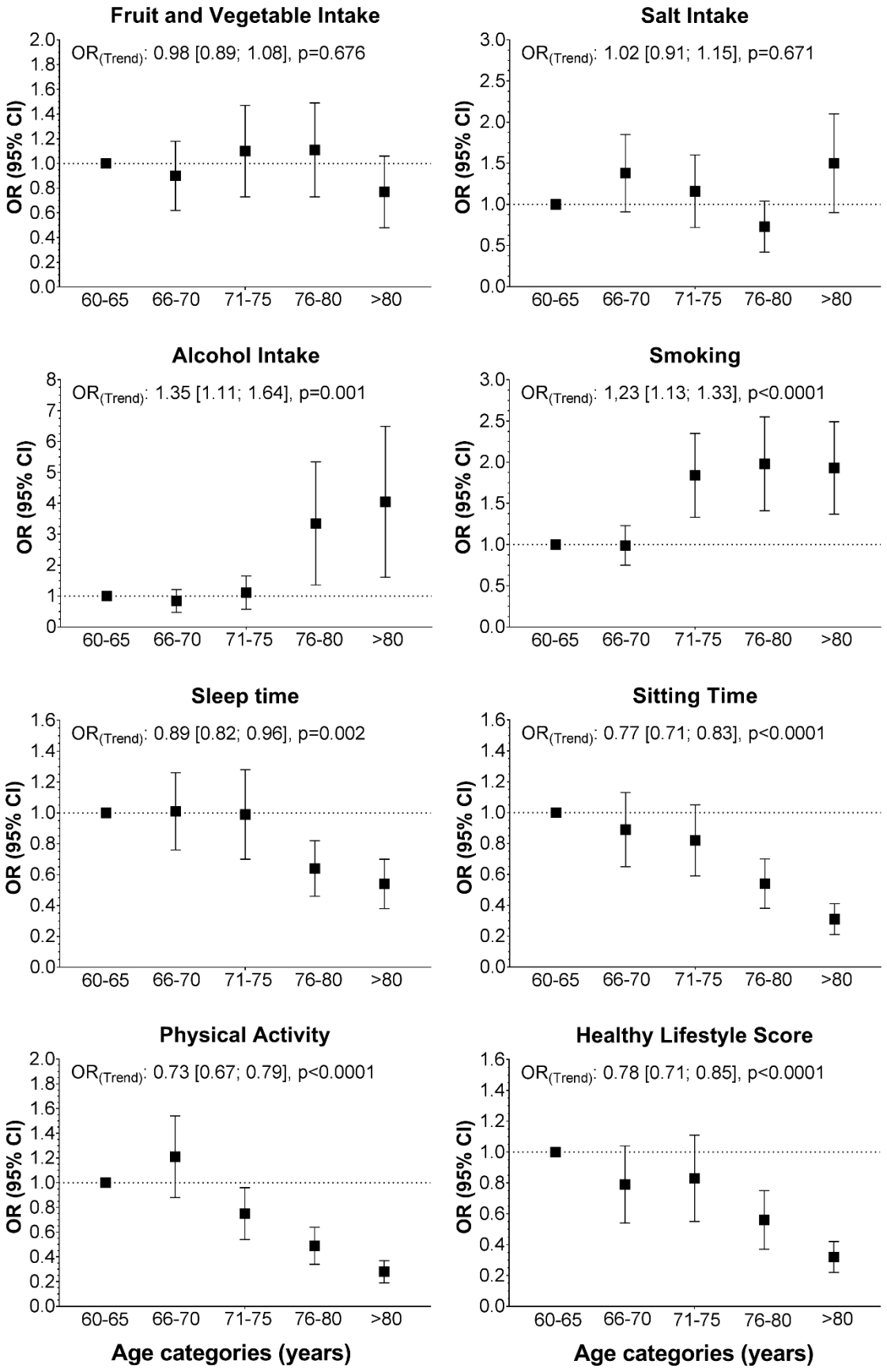

Figure 1. Association between healthy lifestyle recommendations and age categories in older adults

Data is presented as odds ratio and their respective 95% CI (OR (95% CI)). Trends for OR were estimated by fitting age as an ordinal variable in our models, therefore the OR value represent the odds equivalent to moving one category up in age. For age categories, those participants with ages between 60 and 65 years were used as reference group. For lifestyle-related behaviours, meeting the recommendation was used as reference group. The cut-off points used for each lifestyle behaviour were as follows: fruit and vegetable intake (consumption of ≥5 portions of fruit and vegetables per day); b) salt intake (<8 g/day), alcohol intake (<8 AUDIT score points), Self-reported sleeping time (between 7 to 9 hours/day), smoking (being a non-smoker), physical activity (>600 MET/min/week) and sitting time (<4 hours/day). For the healthy lifestyle score, those with a score ≥4 points (healthy individuals) were used as a reference group. All analyses were adjusted for sex, education, gross income, residence zone (urban, rural), education, gross income and BMI.

4. Discussion

4.1 Main findings of this study

The main findings of this study were that within the Chilean population, older adults were less likely to meet the healthy lifestyle guidelines, especially those related to physical activity, time spent sitting and sleep duration. However, older adults were more likely to meet alcohol intake recommendations and be non-smokers compared to those aged between 60 and 65 years. With an increasing proportion of older adults in Chile, clear policies are needed to promote healthy lifestyle behaviours across the lifespan especially in older adults, who will be more likely to become ill (Freitas and others 2016), and therefore increase the personal burden andthe social and health care expenses of the National Health System (WHO 2017a). These findings could also inform stakeholders on which lifestyle behaviours should be targeted through public health policies or early interventions in order to promote healthy ageing in the older population.

The older Chilean population are characterised by being represented by a high proportion of individuals with low income, low levels of education (up to primary), lack of physical activity and too much time spent sitting, which as shown previously may lead to social isolation, disability, fragility, depression, cognitive impairment, and therefore a reduced well-being (WHO 2015a; WHO 2017b). These characteristics are to some extent similar to those reported for other older European and Latin-American populations (Koh and others 2014; MSSSI 2012; Wong and others 2017). However, this study is one of the first ones to investigate how the adherence to healthy lifestyle behaviours varies across the Chilean older population. Our findings are comparable to those results reported in other Latin-American countries with regard to changes in smoking (MSSSI 2012), physical activity (MSSSI 2012), alcohol (Carrasco and

others 2010), salt, fruit and vegetable intake (Machado and others 2016; Sánchez-Ruiz and others 2014) in the older population. Moreover, studies conducted in high income countries have reported that maintaining healthy behaviours in older adults such as sufficient levels of physical activity (Daskalopoulou and others 2017), low levels of sitting time (Dogra and Stathokostas 2012; Viña and others 2016), and adequate levels dietary intake (Kiefte-de Jong and others 2014) could predict healthy ageing.

The findings of this study contribute to answering a major gap in our current knowledge with regard to adherence to lifestyle behaviours in the Chilean older population. Moreover, it could help with informing future interventions or public health policies with regards to identify healthy lifestyle behaviours that are more likely to be above or below current guidelines.

4.2 Strengths and Limitations of the study

Although the CNHS 2009-2010 is a nationally representative sample of the adult Chilean population, this study used a subset of the original cohort including only participants aged >60 years. This could reduce the generalisability of our findings. However, the inclusion of a wide range of health, demographic and behavioural variables in the dataset allowed for a comprehensive adjustment for the effect of confounding factors. Nevertheless, the lifestyle exposures such as alcohol, fruit and vegetable intake and physical activity were self-reported which have previously been shown to be prone to self-reported bias (Celis-Morales and others 2015a; Celis-Morales and others 2012). This could obscure the true association between lifestyle factors and ageing, and therefore future studies using objective measures for physical activity and better methods for dietary intake assessment are required. Coding our outcomes as binary did also reduce our ability to explore a dose-response association between the exposure and the outcome. Moreover, the derived unweighted lifestyle score assumes an equal contribution of each of the lifestyle factors, which may not be true. Therefore future studies should explore whether the trends observed in this study are replicated when a weighted-lifestyle score is used as the exposure. It is also relevant to consider the potential survival bias effect. Smokers and individuals with high alcohol intake across the lifecourse may be less likely to have survived to the oldest age categories, which could influence our findings. Similarly, due to the cross-sectional nature of the study, differences by age observed in this study could also be explained by cohort effects. Finally, this study does not permit any causal inference from these results due to its cross-sectional nature.

In conclusion, lack of physical activity, too much time spent sitting and abnormal sleep behaviour are the main factors associated with ageing in the Chilean population. In this context, and considering the fast demographic changes of ageing due to the increase in life expectancy in Chile, identifying patterns of lifestyle behaviours that are likely to

change as we age could inform stakeholders on the design of policies and interventions to promote healthy ageing through maintaining healthy lifestyle behaviours across the lifespan but especially in older adults.

Financial support

This study was funded by the Chilean Health Ministry as part of the second health surveillance in Chile. The funders of the study had no role in study design, data collection, data analysis, data interpretation or any decision related to this manuscript.

Acknowledgements

We thank all participants for their co-operation and the Chilean Health Ministry and Department of Public Health, The Pontificia Universidad Católica de Chile for commissioning, designing and conducting the second National Health Survey 2009-2010. This work was conducted on behalf of the ELHOC (Epidemiology of Lifestyle and Health Outcomes in Chile) research consortium.

Declarations of interest: None

References

Aguilar-Farias, N.; Leppe Zamora, J. Is a single question of the Global Physical Activity Questionnaire (GPAQ) valid for measuring sedentary behaviour in the Chilean population? Journal of Sports Sciences:1-6; 2016

Alvarado, M.E.; Garmendia, M.L.; Acuña, G.; Santis, R.; Arteaga, O. Validez y confiabilidad de la versión chilena del Alcohol Use Disorders Identification Test (AUDIT). Revista médica de Chile. 137:1463-1468; 2009

Carrasco, M.; Martinez, G.; Foradori, A.; Hoyl, T.; Valenzuela, E.; Quiroga, T.; Gac, H.; Ihle, S.; Marin, P.P. [A novel method for targeting and characterizing healthy older people]. Revista medica de Chile. 138:1077-1083; 2010

Celis-Morales, C.; Livingstone, K.M.; Woolhead, C.; Forster, H.; O'Donovan, C.B.; Macready, A.L.; Fallaize, R.; Marsaux, C.F.M.; Tsirigoti, L.; Efstathopoulou, E.; Moschonis, G.; Navas-Carretero, S.; San-Cristobal, R.; Kolossa, S.; Klein, U.L.; Hallmann, J.; Godlewska, M.; Surwillo, A.; Drevon, C.A.; Bouwman, J.; Grimaldi, K.; Parnell, L.D.; Manios, Y.; Traczyk, I.; Gibney, E.R.; Brennan, L.; Walsh, M.C.; Lovegrove, J.A.; Martinez, J.A.; Daniel, H.; Saris, W.H.M.; Gibney, M.; Mathers, J.C. How reliable is internet-based self-reported identity, socio-demographic and obesity measures in European adults? Genes & nutrition. 10:476-476; 2015a

Celis-Morales, C.; Lyall, D.M.; Guo, Y.; Steell, L.; Llanas, D.; Ward, J.; Mackay, D.F.; Biello, S.M.; Bailey, M.E.; Pell, J.P.; Gill, J.M. Sleep characteristics modify the association of genetic predisposition with

obesity and anthropometric measurements in 119,679 UK Biobank participants. The American Journal of Clinical Nutrition; 2017

Celis-Morales, C.; Salas, C.; Alduhishy, A.; Sanzana, R.; Martinez, M.; Leiva, A.; Diaz, X.; Martinez, C.; Alvarez, C.; Leppe, J.; Munro, A.; Siervo, M.; Willis, N. Socio-demographic patterns of physical activity and sedentary behaviour in Chile: results from the National Health Survey 2009–2010. Journal of Public Health. 38:e98-e105; 2015b

Celis-Morales, C.A.; Perez-Bravo, F.; Ibañez, L.; Salas, C.; Bailey, M.E.; Gill, J.M. Objective vs. self-reported physical activity and sedentary time: effects of measurement method on relationships with risk biomarkers. PLoS ONE. 7:e36345; 2012

Daskalopoulou, C.; Stubbs, B.; Kralj, C.; Koukounari, A.; Prince, M.; Prina, A.M. Physical activity and healthy ageing: A systematic review and meta-analysis of longitudinal cohort studies. Ageing Research Reviews. 38:6-17; 2017

Dogra, S.; Stathokostas, L. Sedentary Behavior and Physical Activity Are Independent Predictors of Successful Aging in Middle-Aged and Older Adults. Journal of Aging Research. 2012:8; 2012

Freitas, C.; Deschenes, S.; Au, B.; Smith, K.; Schmitz, N. Evaluating lifestyle and health-related characteristics of older adults with co-occurring depressive symptoms and cardiometabolic abnormalities. International journal of geriatric psychiatry. 31:66-75; 2016

Gallicchio, L.; Kalesan, B. Sleep duration and mortality: a systematic review and meta-analysis. Journal of Sleep Research. 18:148-158; 2009

Guevara, E. [The importance of knowing "than expected for age" in cognitive assessment of the elderly patient]. Revista medica de Chile. 144:1621; 2016

IPAQ. Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ) - Short Form,Version 2.0. IPAQ; 2004

Kiefte-de Jong, J.C.; Mathers, J.C.; Franco, O.H. Nutrition and healthy ageing: the key ingredients. Proceedings of the Nutrition Society. 73:249-259; 2014

Koh, E.S.; Jang, S.N.; Paik, N.J.; Kim, K.W.; Lim, J.Y. Age and gender patterns in associations between lifestyle factors and physical performance in older Korean adults. Archives of gerontology and geriatrics. 59:338-345; 2014

Machado, R.H.V.; Feferbaum, R.; Leone, C. Fruit intake and obesity Fruit and vegetables consumption and obesity in Brazil. 2016. 26:10; 2016

MINSAL. Encuesta Nacional de Salud 2009-2010. Santiago, Chile: Ministerio de Salud; 2009

MINSAL. Encuesta Nacional de Salud 2009-2010. Chile: Ministerio de Salud; 2010

MSSSI. Spain National Health Survey 201-2012. Ministerio de Sanidad, Servicios Sociales e Igualdad. Available: https://www.msssi.gob.es/estadEstudios/estadisticas/encuestaNacional/encuesta2011.htm; 2012

PAHO. Clinical evaluation modules. Module 5: Nutritional Assessment of older adults. Pan-American Health Organization. Available: http://www.sld.cu/galerias/pdf/sitios/gericuba/modulo5.pdf; 2003

PAHO. Herramienta para Vigilancia de ENTs: Factores de Riesgo para Enfermedades No Transmisibles. Pan American Health Organization; 2012

Sánchez-Ruiz, F.; De la Cruz-Mendoza, F.; Cereceda-Bujaico, M.; Espinoza-Bernardo, S. Asociación de hábitos alimentarios y estado nutricional con el nivel socioeconómico en adultos mayores que asisten a un Programa Municipal. Anales de la Facultad de Medicina. 75:107-111; 2014

Santis, R.; Garmendia, M.L.; Acuna, G.; Alvarado, M.E.; Arteaga, O. The Alcohol Use Disorders Identification Test (AUDIT) as a screening instrument for adolescents. Drug and alcohol dependence. 103:155-158; 2009

Saunders, J.B.; Aasland, O.G.; Babor, T.F.; de la Fuente, J.R.; Grant, M. Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO Collaborative Project on Early Detection of Persons with Harmful Alcohol Consumption--II. Addiction (Abingdon, England). 88:791-804; 1993a

Saunders, J.B.; Aasland, O.G.; Babor, T.F.; De La Fuente, J.R.; Grant, M. Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO Collaborative Project on Early Detection of Persons with Harmful Alcohol Consumption-II. Addiction. 88:791-804; 1993b

Sodergren, M.; Wang, W.C.; Salmon, J.; Ball, K.; Crawford, D.; McNaughton, S.A. Predicting healthy lifestyle patterns among retirement age older adults in the WELL study: a latent class analysis of sex differences. Maturitas. 77:41-46; 2014

Tanaka, T.; Okamura, T.; Miura, K.; Kadowaki, T.; Ueshima, H.; Nakagawa, H.; Hashimoto, T. A simple method to estimate populational 24-h urinary sodium and potassium excretion using a casual urine specimen. Journal of human hypertension. 16:97-103; 2002

Viña, J.; Rodriguez-Mañas, L.; Salvador-Pascual, A.; Tarazona-Santabalbina, F.J.; Gomez-Cabrera, M.C. Exercise: the lifelong supplement for healthy ageing and slowing down the onset of frailty. The Journal of Physiology. 594:1989-1999; 2016

WHO. Waist Circumference and Waist-Hip Ratio: Report of a WHO Expert Consultation. Geneva: World Health Organization; 2008

WHO. Global Physical Activity Questionnaire: GPAQ version 2.0. World Health Organization; 2009

WHO. Ageing and health. World Health Organization. Available: http://www.who.int/mediacentre/factsheets/fs404/en/; 2015a

WHO. Questions and Answers on hypertension. World Health Organization; 2015b

WHO. 10 facts on ageing and health. World Health Organization. Available: http://www.who.int/features/factfiles/ageing/en/; 2017a

WHO. Mental health of older adults. World Health Organization. Available: http://www.who.int/mediacentre/factsheets/fs381/en/; 2017b

Wong, R.; Michaels-Obregon, A.; Palloni, A. Cohort Profile: The Mexican Health and Aging Study (MHAS). International journal of epidemiology. 46:e2; 2017