International Journal of Obesity (2019) 43:938–941
https://doi.org/10.1038/s41366-018-0179-x

BRIEF COMMUNICATION

Behavior, Psychology and Sociology

Subjective age and adiposity: evidence from five samples

Yannick Stephan[1] · Angelina R. Sutin[2] · Antonio Terracciano[2]

Received: 2 February 2018 / Revised: 23 June 2018 / Accepted: 1 July 2018 / Published online: 24 September 2018

Abstract

Obesity is a significant public health issue with increasing prevalence among middle-aged and older adults. The present study tested whether subjective age, that is how old or young individuals perceive themselves to be, is related to both BMI and waist circumference in five samples of middle-aged and older adults (total $N > 24{,}000$; aged 34 to 105 years). Cross-sectional analyses that accounted for demographic variables revealed that an older subjective age was related to higher BMI and waist circumference in the five samples. Feeling older was related to a 10–20% higher likelihood of BMI ≥ 30 and a 11–25% higher likelihood of exceeding the obesity-related threshold for waist circumference. For most associations, age felt was more consistently and strongly related to adiposity than chronological age. The overall pattern was confirmed by a meta-analysis of the five samples. The present research adds subjective age to the list of factors related to obesity across adulthood.

Obesity is a significant public health issue for all age groups, including the second half of the lifespan. Obesity accelerates age-related decline in functional and cognitive abilities [1, 2] and is related to chronic disease [3] and all-cause mortality [4]. Given that the number of older individuals with obesity is rising [5], there is a need to better understand the factors associated with adiposity in middle and old age. A growing body of research suggests that subjective age, or how old or young individuals feel relative to their chronological age, deserves particular attention as a factor associated with a range of health-related outcomes in adulthood. An older subjective age, for example, is related to higher risk of chronic conditions [6], dementia [7], and mortality [8]. At the biological level, individuals who feel older than their age have higher levels of systemic inflammation [9] and cystatin C [10]. At the behavioral level, an older subjective age is associated with behaviors conducive to obesity, such as physical inactivity [11].

Consistent with this body of research, feeling older has been associated with higher waist circumference in the HRS [12] and to lower cognitive performance and increasing cystatin C over time through its association with higher body mass index (BMI) [10, 13]. Previous studies, however, have examined adiposity markers as explanatory mechanisms of other associations. Furthermore, previous studies that have included adiposity relied either on a single indicator (BMI or waist circumference) or used self-reported measures of height and weight.

The present study sought to extend existing knowledge by examining the link between subjective age and both BMI and waist circumference in five large samples of middle-aged and older adults. We hypothesized that an older subjective age is associated with higher BMI and larger waist circumference.

Method

Participants

Participants were drawn from the Wisconsin Longitudinal Study graduate (WLSG) and sibling (WLSS) samples, the Midlife in the United States Survey (MIDUS), the Health and Retirement Study (HRS), and the National Health and Aging Trends Survey (NHATS). In the five samples, participants with complete data on subjective age, BMI, waist circumference, and demographic factors were included. Descriptive statistics are presented in Supplementary Table 1. The large sample sizes in each sample provided sufficient power (>80%) to detect small effects.

Electronic supplementary material The online version of this article (https://doi.org/10.1038/s41366-018-0179-x) contains supplementary material, which is available to authorized users.

✉ Yannick Stephan
yannick.stephan@umontpellier.fr

[1] Euromov, Univ. Montpellier, Montpellier, France

[2] College of Medicine, Florida State University, Tallahassee, USA

Table 1 Linear regression analysis predicting BMI and waist circumference from subjective age in the five samples

Variables	WLSG		WLSS		MIDUS II		NHATS		HRS	
	BMI	Waist	BMI	Waist	BMI	Waist	BMI	Waist	BMI	Waist
Age	0.01	−0.02	−0.08***	0.00	−0.03	0.07*	−0.24***	−0.10***	−0.14***	−0.03***
Sex	0.06***	0.27***	0.10***	0.33***	0.08**	0.42***	−0.02	0.22***	−0.03**	0.22***
Race	–	–	–	–	−0.09**	−0.05	−0.08***	−0.03**	−0.05***	−0.04***
Education	−0.11***	−0.08***	−0.10***	−0.07***	−0.09*	−0.09**	−0.06***	−0.06***	−0.08***	−0.09***
Subjective age	0.13***	0.14***	0.08***	0.10***	0.05	0.04	0.07***	0.10***	0.05***	.09***
Meta-analysis										
Random effect BMI	0.08 (0.046–0.109) ***									
Heterogeneity (I^2)	80.72									
Random effect Waist	0.10 (0.076–0.123) ***									
Heterogeneity (I^2)	65.81									

Note: WLSG: $N = 4275$; WLSS: $N = 2287$; MIDUS II: $N = 973$; NHATS: $N = 6012$; HRS: $N = 11136$

Coefficients are standardized coefficients. For subjective age, higher values indicate feeling older

$^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

The Wisconsin Longitudinal Study (WLS) is a long-term study of a random sample of 10,317 men and women who graduated from Wisconsin high schools in 1957. The study includes selected siblings (WLSS) of some of the graduates (WLSG). Complete data were obtained in 2011 from 4275 WLSG participants (53% women, mean age = 71.18, SD = 0.90) and from 2287 WLSS participants (52% women, mean age = 69.21, SD = 6.66).

The MIDUS is a sample of non-institutionalized, English-speaking adults. Data were drawn from the second wave (2004–2009, MIDUS II) from a total of 973 participants (54% women, mean age = 55.37, SD = 11.78).

The HRS is a national longitudinal study of Americans older than 50 years and their spouses. Data were drawn from face-to-face interviews in 2012 (for a random half of the sample) and 2014 (for the other half of the sample) and were pooled, resulting in a total of 11,136 participants (59% women, mean age = 68.01, SD = 10.27).

The NHATS is a nationally representative prospective cohort study of Medicare enrollees aged 65 years and older. Data were collected at the first wave in 2011 ($n = 6012$, 57% women, mean age = 76.88, SD = 7.56).

Measures

Subjective age

In the five samples, a single question asked participants to indicate how old they felt in years. Chronological age was subtracted from felt age and then divided by chronological age, which results in a proportional discrepancy score [7]. A positive score indicates an older subjective age, whereas a negative score indicates a younger subjective age. In all samples, participants with scores three standard deviations above or below the mean were excluded: WLSG ($n = 64$), the WLSS ($n = 31$), the MIDUS II ($n = 13$), the HRS ($n = 34$), and the NHATS ($n = 97$).

Adiposity

BMI was derived as kg/m^2 from weight and height assessed by trained staff (an interviewer or a nurse) in the WLSG, the WLSS, the MIDUS II, and the HRS. Weight was measured using a scale in these four samples after shoes, heavy objects, and bulky clothing were removed. Height was measured by asking participants to stand against a wall, without shoes. A mark was made on the wall and height was measured as the distance from the floor to the mark. In the NHATS, participants were asked to report their weight and height. Waist circumference was measured at the level of the navel in the five samples by the interviewer or a nurse.

Data analysis

Linear regression was conducted in the five samples to examine whether subjective age was related to BMI and waist circumference. Age, sex, and education were included as covariates. Race was also included in MIDUS II, HRS, and NHATS. Race was not included in the WLS samples because these samples only included white participants, which is representative of Wisconsin in the 1950s (~99% white). Logistic regression that included the same set of covariates was conducted to test whether subjective age was associated with obesity, defined as a BMI ≥ 30, and waist

Table 2 Logistic regression predicting obesity from subjective age

	WLSG Odds ratios (95% CI)	WLSS Odds ratios (95% CI)	MIDUS II Odds ratios (95% CI)	NHATS Odds ratios (95% CI)	HRS Odds ratios (95% CI)
BMI					
Age	0.99 (0.95–1.03)	0.98 (0.97–0.99)***	0.99 (0.98–1.00)	0.94 (0.93–0.95)***	0.99 (0.97–0.98)***
Sex	1.39 (1.23–1.57)***	1.52 (1.28–1.80)***	1.15 (0.88–1.50)	0.76 (0.67–.085)***	0.92 (0.85–0.99)*
Race	–	–	0.65 (0.37–1.12)	0.71 (0.63–0.81)***	0.78 (0.71–0.86)***
Education	0.82 (0.77–0.87)***	0.81 (0.74–0.88)***	0.84 (0.74–0.96)*	0.87 (0.82–0.93)***	0.95 (0.94–0.96)***
Subjective age	1.21 (1.14–1.29)***	1.11 (1.02–1.21)*	1.00 (0.99–1.00)	1.17 (1.11–1.25)***	1.10 (1.06–1.14)***
Meta-analysis	1.11 (1.02–1.21)*				
Heterogeneity (I^2)	94.94				
Waist circumference					
Age	0.94 (0.87–1.02)	1.00 (0.98–1.01)	1.02 (1.01–1.03)***	0.99 (0.98–0.99)***	1.00 (1.00–1.00)
Sex	0.63 (0.55–0.72)***	0.78 (0.66–0.93)**	0.93 (0.72–1.20)	0.38 (0.34–0.43)***	0.45 (0.42–0.49)***
Race	–	–	0.83 (0.47–1.45)	0.97 (0.86–1.10)	0.87 (0.79–0.97)**
Education	0.85 (0.80–0.91)***	0.84 (0.77–0.92)***	0.84 (0.74–0.95)**	0.90 (0.85–0.95)***	0.94 (0.93–0.95)***
Subjective age	1.25 (1.17–1.34)***	1.11 (1.02–1.21)*	1.10 (0.97–1.25)	1.16 (1.10–1.23)***	1.14 (1.10–1.19)***
Meta-analysis	1.16 (1.11–1.21)***				
Heterogeneity (I^2)	42.42				

Note: WLSG: $N = 4275$; WLSS: $N = 2287$; MIDUS II: $N = 973$; NHATS: $N = 6012$; HRS: $N = 11136$

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

circumference of ≥102 cm (40 in.) for men and ≥88 cm (35 in.) for women.

The results from each sample were combined in a random-effects meta-analysis to provide a quantitative synthesis of the relation between subjective age and both BMI and waist circumference.

Results

Consistent with our hypothesis, linear regression analysis revealed that an older subjective age was related to higher BMI and waist circumference in four out of the five samples (Table 1). The meta-analyses confirmed the association between subjective age and both BMI and waist circumference, but also found significant heterogeneity. Supplemental bootstrap analysis ($N = 5000$) further revealed that lower physical activity and higher depressive symptoms partially mediated the relationships observed between an older subjective age and adiposity in most samples (Supplementary Table 2). And, although the total relationship between subjective age and adiposity was not significant in the MIDUS II, there was an indirect effect through physical activity and depressive symptoms (Supplementary Table 2).

Logistic regression analysis revealed that an older subjective age was predictive of a greater likelihood of obesity, except in the MIDUS II. Across the four samples, a SD older subjective age was associated with a 10–20% higher likelihood of BMI ≥ 30 (Table 2), and a 11–25% higher likelihood of exceeding the obesity-related threshold for waist circumference (Table 2). The meta-analysis confirmed the overall pattern of associations. Individuals with an older subjective age had higher BMI and waist circumference compared to those with a younger subjective age (Supplementary Table 3).

Discussion

The present study provides consistent evidence for an association between subjective age and adiposity markers in five samples of middle-aged and older adults. Specifically, an older subjective age was related to higher BMI and waist circumference and a higher likelihood of obesity. Therefore, the present research adds subjective age to the list of factors related to obesity across adulthood. It contributes to the literature by examining the largest sample size to date and by including both waist circumference and BMI.

Our supplemental analysis revealed that individuals who felt older were more likely to be obese in part because they were less physically active and had more depressive symptoms. Several additional pathways may also explain this association with adiposity. At the behavioral level, feeling older may be related to unbalanced diet that leads to higher obesity risk. At the psychological level, individuals who feel older tend to score lower on conscientiousness [14] and are more likely to report maladaptive stress reactivity [15], which in turn are implicated in overweight and obesity [16, 17]. At the biomedical level, an older subjective age is related to more chronic conditions and to a less healthy inflammatory profile [9], which are consistent with and may potentially explain the current findings. Subjective age is a biopsychosocial marker of aging that may be sensitive to a range of behavioral, biological, and psychological factors implicated in adiposity, which may explain why it is more consistently and strongly related to adiposity markers than chronological age.

Despite its strengths, the present study has several limitations. First, the observational and cross-sectional study design did not allow causal interpretations. Although existing research suggests that subjective age is likely to predict adiposity, reciprocal relations may also exist. Indeed, individuals with obesity may engage in less physical activity, which may lead to feeling older. Second, the results obtained in the present study were obtained from US samples. Future research is needed to examine whether there are cross-cultural variations in the association between subjective age and adiposity. Despite these limitations, the present study provides clear evidence of an association between the age individuals feel and BMI and waist circumference in middle and older adulthood, beyond chronological age. It suggests that subjective age may be a robust indicator of obesity risk in middle and old age.

Acknowledgements The Wisconsing Longitudinal Study (WLS) has been supported principally by the National Institute on Aging (AG-9775, AG-21079, AG-033285, and AG-041868), with additional support from the Vilas Estate Trust, the National Science Foundation, the Spencer Foundation, and the Graduate School of the University of Wisconsin-Madison. WLS was approved by the Institutional Review Board at the University of Wisconsin-Madison. WLS data are available at: http://www.ssc.wisc.edu/wlsresearch/. The Health and Retirement Study (HRS) is sponsored by the National Institute on Aging (NIAU01AG009740) and conducted by the University of Michigan. HRS was approved by the University of Michigan Institutional Review Board. HRS data are available at: http://hrsonline.isr.umich.edu/index.php. The Midlife in the United States study 2 (MIDUS 2) was supported by grants from the National Institute on Aging (P01AG020166). Additional grants were obtained from grants from the General Clinical Research Centers Program (M01-RR023942, M01-RR00865) and the National Center for Advancing Translational Sciences (UL1TR000427). MIDUS was approved by the Education and Social/Behavioral Sciences and the Health Sciences Institutional Review Boards at the University of Wisconsin–Madison. MIDUS data are available at: http://midus.wisc.edu/index.php.The NHATS is sponsored by the National Institute on Aging (grant number NIA U01AG032947) through a cooperative agreement with the Johns Hopkins Bloomberg School of Public Health. NHATS was approved by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board. NHATS data are available at: http://www.nhats.org/. Participants provided informed consent in the five samples

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

1. Bell JA, Sabia S, Singh-Manoux A, Hamer M, Kivimäki M. Healthy obesity and risk of accelerated functional decline and disability. Int J Obes. 2017;41:866–72.
2. Singh-Manoux A, Czernichow S, Elbaz A, Dugravot A, Sabia S, Hagger-Johnson G, et al. Obesity phenotypes in midlife and cognition in early old age: the Whitehall II cohort study. Neurology. 2012;79:755–62.
3. Stenholm S, Head J, Aalto V, Kivimäki M, Kawachi I, Zins M, et al. Body mass index as a predictor of healthy and disease-free life expectancy between ages 50 and 75: a multicohort study. Int J Obes. 2017;41:769–75.
4. Jacobs EJ, Newton CC, Wang Y, Patel AV, McCullough ML, Campbell PT, et al. Waist circumference and all-cause mortality in a large US cohort. Arch Intern Med. 2010;170:1293–301.
5. Flegal KM, Carroll MD, Ogden CL, Curtin LR. Prevalence and trends in obesity among US adults, 1999-2008. JAMA. 2010;303:235–41.
6. Demakakos P, Gjonca E, Nazroo J. Age identity, age perceptions, and health: evidence from the English longitudinal study of ageing. Ann NY Acad Sci. 2007;1114:279–87.
7. Stephan Y, Sutin AR, Luchetti M, Terracciano A. Feeling older and the development of cognitive impairment and dementia. J Gerontol B Psychol Sci Soc Sci. 2017;72:966–73.
8. Rippon I, Steptoe A. Feeling old vs being old: associations between self-perceived age and mortality. JAMA Intern Med. 2015;175:307–9.
9. Stephan Y, Sutin AR, Terracciano A. Younger subjective age is associated with lower C-reactive protein among older adults. Brain Behav Immun. 2015;43:33–36.
10. Stephan Y, Sutin AR, Terracciano A. Subjective age and cystatin C among older adults. J Gerontol B Psychol Sci Soc Sci. in press.
11. Wienert J, Kuhlmann T, Fink S, Hambrecht R, Lippke S. Testing principle working mechanisms of the health action process approach for subjective physical age groups. Res Sports Med. 2016;24:67–83.
12. Stephan Y, Sutin AR, Terracciano A. How old do you feel? The role of age discrimination and biological aging in subjective age. PLoS ONE. 2015;10:e0119293.
13. Stephan Y, Caudroit J, Jaconelli A, Terracciano A. Subjective age and cognitive functioning: a 10-year prospective study. Am J Geriatr Psychiatry. 2014;22:1180–7.
14. Stephan Y, Sutin AR, Terracciano A. Subjective age and personality development: a 10-year study. J Pers. 2015;83:142–54.
15. Shrira A, Palgi Y, Ben-Ezra M, Hoffman Y, Bodner E. A youthful age identity mitigates the effect of post-traumatic stress disorder symptoms on successful aging. Am J Geriatr Psychiatry. 2016;24:174–5.
16. Jokela M, Hintsanen M, Hakulinen C, Batty GD, Nabi H, Singh-Manoux A, et al. Association of personality with the development and persistence of obesity: a meta-analysis based on individual–participant data. Obes Rev. 2013;14:315–23.
17. Epel E, Lapidus R, McEwen B, Brownell K. Stress may add bite to appetite in women: a laboratory study of stress-induced cortisol and eating behavior. Psychoneuroendocrinology. 2001;26:37–49.