

Assessment of healthy lifestyles in relation to BMI

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Submitted: 2022-09-28 *Accepted:* 2022-10-30 *Published online:* 2022-10-30

Key words: **lifestyle; BMI; adults; movement; diet; sleep**

Neuroendocrinol Lett 2022; **43**(7-8):393-399 PMID: 36720128 NEL437822A06 ©2022 Neuroendocrinology Letters • www.nel.edu

Abstract

THEORETICAL BASIS: A sedentary lifestyle, consumption of inappropriate food, smoking or alcohol consumption can contribute to the overall deterioration of lifestyle and lead to weight gain. Lifestyle includes nutrition, physical activity, sleep, psychological well-being, good relationships or job satisfaction. We can influence some parts of our lifestyle, but we cannot influence many other factors like genetic predisposition or the environment in which we live.

OBJECTIVE OF STUDY: The objective of the study is to evaluate the relationship between lifestyle and BMI (Body Mass Index), as well as differences based on age and sex.

METHODOLOGY: A self-constructed questionnaire containing 71 questions was used to determine information about lifestyle. The collected data was based on the assessment of body mass index (BMI) and age, all respondents were measured using the stadiometer and InBody 270. The group included 323 adults (156 men and 167 women) and was divided according to BMI (BMI lower than 25 kg/m², and BMI of 25 kg/m² or higher). The selected lifestyle characteristics were grouped to create a positive score including positive lifestyle factors, a negative score including negative lifestyle factors, and an overall healthy lifestyle score that included positive and negative scores.

RESULTS: We found out that physiological BMI (18.5-24.9 kg/m²) was more common in respondents with higher education and students. The most respondents prefer omnivorous diet, in lower BMI group were mainly non-smokers and occasional consumers of alcohol, in comparison to higher BMI group where were former smokers and those who abstained from alcohol. All scales of lifestyle are sex-related and negative healthy lifestyle score also depend on BMI. Effect of age is not significant.

CONCLUSIONS: According to our study, people with a physiological BMI have a significantly healthier lifestyle compared to overweight or obese people. The overall lifestyle values, as well as the positive and negative lifestyle scores, depend on sex; the negative healthy lifestyle score also depends on BMI.

Abbreviations:

BMI	- Body Mass Index	kg	- kilograms
CVD	- Cardiovascular Disease	m	- meter
e.g.	- exempli gratia	NS	- Not Significant
HL	- Healthy Lifestyle	SD	- Standard Deviation
i.e.	- id est	WHO	- World Health Organisation

INTRODUCTION

Lifestyle was defined by the World Health Organization (WHO) as early as 1999 as a way of living that minimises the risk of being seriously ill or dying early. At the same time WHO stated that not all diseases are preventable, yet it is possible to prevent diseases of the heart and blood vessels, but also, for example, lung cancer. Further stating healthy lifestyle to be dependent on way of living that promotes the enjoyment of many aspects of life, where health is not just an absence of disease, but a psychological, mental and social well-being for enjoying of more aspects of life for a longer period of time.

Among other things, the WHO also describes a healthy lifestyle as a way of life that helps the whole family, because it assumes that the lifestyle is transmitted to other members of the family, especially children. Lifestyle components include smoking, physical activity, healthy eating, and alcohol consumption (WHO, 1999).

BMI (body mass index), originally referred to as Quetelet's body mass index after its author, expresses the relationship between body weight and body height.

$$\text{BMI} = \frac{\text{body weight (kg)}}{\text{body height}^2 \text{ (m)}}$$

BMI is an indicator for effective evaluation of physical condition indicating ideal weight to height ratio, or overweight and obesity as possible risk factor for disease. According to the WHO, the BMI range 18.5–24.9 kg/m² corresponds to ideal (physiological BMI), BMI 25–29.9 kg/m² as overweight, and 30 kg/m² or higher as obesity (WHO, 2010; CDC, 2022).

MATERIAL AND METHODS

The research group consisted of adults living in the South Bohemian region, aged 18 to 65 years, who voluntarily participated in the research. Respondents were informed about the data collection purpose and about anonymising of obtained data. A total of 323 people (156 men and 167 women) participated.

The group of participants were selected randomly. General practitioners working in the South Bohemian region and their registered patients were approached.

Contraindications were pregnancy, a pacemaker or the absence of a limb (due to the bioimpedance measurement that was part of the study). All participants agreed with participation in the research.

Respondents were divided into 8 groups according to their sex, BMI (<25 kg/m² and ≥25 kg/m², respectively) and age (18–41 years, and 42–65 years, respectively) and each group was required to consist of at least 30 respondents to satisfy the statistical needs. 3% of the data was obtained from study authors' collaborators, due to the need to supplement the groups.

All respondents completed a 71-item questionnaire developed by us, which included lifestyle related questions, e.g. eating, exercising, sleeping, and data on employment, relationships with others, etc.

From the lifestyle-related questions we have selected 32 which according to the current scientific literature are most closely reflecting a good or bad lifestyle behaviour. The respondents were awarded a positive score of +1 or +2 points or a negative score of –1 or –2 points for the most healthy and unhealthy response, respectively (see below). A maximum score of 21 (positive) and 19 (negative) points could be achieved.

A Total "healthy lifestyle compliance" (HL) score was then as a sum of the positive and negative scores. To aid the comparisons, the scores were transformed to a 0–100% scale (where the endpoints of the respective scale, i.e. theoretical minima and maxima, correspond to 0 and 100%, respectively). Particularly, the relative Total HL score was constructed such as the theoretical sum of –19 points corresponds to 0%, and +21 points corresponds to 100 %.

The selected **positive** characteristics included following categories (with the score in the brackets): the non-usage of **medication** (1); the preference of a **omnivorous diet** (1); the consumption of **food 3–5x** a day (1); having the first meal within 1 hour **after waking up** (1); the consumption of 5 portions of **fruit and vegetables** a day (1); the consumption of maximum 1–2 pieces of **fruit** a day (1); drinking of 1.5 or more litres of (non-alcoholic) **beverages** a day (1); the preference of **water** (2), unflavoured mineral water (1) or tea (1); the consumption of **wholegrain bread** at least 4–6x a week (1); the consumption of **fish and legumes** at least 1x a week (1); the consumption of **smoked meats, sweets and sweet and savoury snacks**

Tab. 1. Sex, age and BMI of respondents

	Men		Women		p ^a
	Frequency	Percentage	Frequency	Percentage	
Sex	156	48.3%	167	51.7%	
	Mean	SD	Mean	SD	
Age	39	14	36	14	0.024
BMI	27.3	5.6	26.0	7.4	0.087

^a t test; (BMI – Body Mass Index; SD - Standard Deviation)

Tab. 2. Demographics based on BMI category (<25 kg/m² and ≥25 kg/m²)

Characteristic	Lower BMI (n = 163)		Higher BMI (n = 160)		p ^a	
	Percentage	Frequency	Percentage	Frequency		
Education	Primary	10	6%	20	13%	0.033
	Secondary	96	59%	101	63%	
	Tertiary	57	35%	39	24%	
Marital status	Single	62	38%	55	34%	0.345
	Married	66	41%	67	42%	
	In a partnership	27	16%	21	13%	
	Divorced	7	4%	14	9%	
	Widowed	1	1%	3	2%	
Employment	Employed	99	61%	93	58%	0.003
	Self-employed	9	5%	16	10%	
	Student	47	29%	28	18%	
	Other	8	5%	23	14%	

^a chi-square test

less than once a week (1+1+1), no consumption of **fast food** (1); the consumption of **fried foods** less than once a week (1); regularly engagement in **physical activity** (1); at least 30 minutes of physical activity a day (1); **sleeping** on average 7–9 hours a day (1).

On contrary, a **negative** score was awarded to the following characteristics: the **economic activity** = unemployed (-1); current **smoker** (-2); former **smoker** currently abstaining (-1); frequent or regular **alcohol consumption** (-2); long-term preference of **meat-based and vegan diet** (-2); the preference of **sweetened beverages or juices** (-1); and/or consumption of **sweetened beverages** 4–6x a week (-1); the **consumption of fruit and vegetables** less than once a week (-1); the consumption of **white bread** once or more times a day (-1); **waking up at night** due to hunger (-1) and appetite (-2); no regular **physical activities** (-1); a **sedentary job** (-1); **sleeping** 5 hours or less during the night (-1); working in **continuous or three-shift operation** (-1); having **bad relationships** in their neighbourhood or at work (-1); low **satisfaction with their current employment** (-1).

The data was processed by IBM SPSS 26.0 software. The differences in the mean age and BMI scores between men and women were assessed by a two-sample t-test. The effect of respondents' sex, age and BMI on their lifestyle scores was assessed by regression analysis (using the Enter method). The *p*-value of <0.05 was considered significant.

RESULTS

Descriptive statistics

A total of 323 respondents participated in our research, of which 156 were men (48.3%) and 167 were women (51.7%) (mean age for men 39 years and for women

36 years). Men were significantly older than women by 3 years. The mean BMI was slightly higher in men than in women (NS) which is a value indicating overweight (Table 1).

BMI was related to the education and employment of the respondents – normal weight (lower BMI) was more common in respondents with higher education and students. Marital status showed no significant effect (Table 2).

Table 3 shows selected characteristics of lifestyle including, e.g. smoking, preferred diet or fitness level. In lower BMI group – the most respondents never smoked, prefer drinking of water, do sports regularly and are occasional consumers of alcohol. In higher BMI group – the most respondents are former smokers, do not eat out, do sports regularly and abstain from alcohol.

Entering sex, age and BMI into the regression analysis yielded significant models (*p* < 0.01) albeit with very small adjusted R squared values (0.025–0.050). All three scales of healthy lifestyle (Total HL score, Positive and Negative scores) are sex-dependent (Table 4). Women have higher scores, i.e., show healthier lifestyle than men.

The Negative HL (Healthy Lifestyle) score is also dependent on BMI (*p* = 0.007), with the higher the BMI, the lower the score. The Total HL score has a similar trend, although not significant (*p* = 0.064). Age shows no effect on any of the three HL scores.

To graphically illustrate the effect of sex, age and BMI scores plotted the mean scores of the three HL scales for 8 groups of respondents (Fig. 1; see Methods section).

It can be clearly seen that: 1) the Positive HL score reaches much higher values than the negative counterpart, i.e., the respondents tend to behave fairly well

Tab. 3. Selected components of healthy lifestyle

Variable	Response	Lower BMI (n = 163)		Higher BMI (n = 160)	
		Frequency	Percentage	Frequency	Percentage
Smoking	Current	4	2%	6	4%
	Former	39	24%	86	54%
	Never	120	74%	68	42%
Preferred diet	Omnivorous	158	97%	157	98%
	Meat-based	2	1%	3	2%
	Vegetarian	3	2%	0	0%
5 portions of fruit and vegetables a day	Yes	39	24%	48	30%
	No	124	76%	112	70%
Eating out	Not needed	47	29%	50	31%
	Restaurants	28	17%	27	17%
	Own lunchbox	54	33%	43	27%
	Take away	15	9%	21	13%
	Other	19	12%	19	12%
Preferred beverage types	Water	107	65.5%	86	54%
	Unflavoured mineral water	8	5%	10	6.5%
	Soft drinks	15	9.5%	24	15%
	Tea	25	15%	28	17.5%
	Fruit juice	2	1%	2	1%
Food-related waking up at night	Other	6	4%	10	6%
	Due to hunger	7	4%	6	4%
	Due to appetite	6	4%	10	6%
Regular physical activity	None	150	92%	144	90%
	Yes	134	82%	115	72%
At least 30 minutes of physical activity per day	No	29	18%	45	28%
	Yes	95	58%	82	51%
Employment satisfaction scale	No	68	42%	78	49%
	1 (highly satisfied)	45	28%	39	24%
	2	64	39%	68	43%
	3	36	22%	37	23%
	4	15	9%	8	5%
Fitness level	5 (highly unsatisfied)	3	2%	8	5%
	Excellent	18	11%	6	4%
	Good	87	53%	42	26%
	Average	46	28%	56	35%
	Satisfactory	8	5%	28	17.5%
Alcohol consumption	Poor	4	3%	28	17.5%
	Abstaining	48	29%	89	55%
	Casual consumer	112	69%	70	44%
	Regular/frequent consumer	3	2%	1	1%

Tab. 4. Significance of sex, age and BMI in the regression models and their partial correlation coefficients

Scale	p			Partial correlation coefficient		
	Sex	Age	BMI	Sex	Age	BMI
HL Positive score	0.005	0.486	0.274	0.157	-0.039	-0.061
HL Negative score	0.004	0.326	0.007	0.158	0.055	-0.151
Total HL score	0.002	0.900	0.064	0.176	-0.007	-0.103

regarding their lifestyle preferences; 2) in contrast to women, men persistently show lower Positive scores, higher Negative scores, and lower Total HL scores, i.e., men tend to behave more unhealthy.

To further dissect the differences and to study the possible interactions between the three independent variables an univariate ANOVA model was built for all three HL scores. First the effect of the interaction terms (sex vs. age, sex vs. BMI, sex vs. age vs. BMI) was analysed with no significant results found (not shown).

DISCUSSION

Obesity is a societal problem that needs to be addressed. It is not easy considering the variety of offered foods, the ability to simplify moving from one place to another, etc.

Our results showed that young women (18 to 41 years old) with a higher BMI (≥ 25 kg/m²) and older men (42 to 65 years old) with a higher BMI (≥ 25 kg/m²) differ greatly ($p = 0.048$). Reasons for our observation may be – planning a pregnancy at this age, and as stated by Jelsma *et al.* (2016), lifestyle change can be particularly difficult for overweight and obese women. As part of their research, they mainly focused on women at risk of gestational diabetes (those with an unhealthy lifestyle and high body weight). The research showed that women in this age (planning pregnancy) are willing to undergo a lifestyle changes, especially for the child's health (Jelsma *et al.* 2016).

Puciato and Rozpara (2020) focused on marital status, dividing respondents into single and married. According to their findings, there was a higher number (in both groups) of those who had a normal body weight according to BMI (18,5–24,9 kg/m²), but the differences were statistically significant ($p < 0.001$), there were 73% with a normal weight among the singles and 51% among the married. We divided the respondents into several groups, but if we only focus on the single and married groups, then 117 single and 133 married people were included in these two groups. People with physiological BMI (18,5–24,9 kg/m²) predominated in single group and partnership, 53% of single respondents and 50% of married respondents had a physiological BMI.

De Munter *et al.* (2015) studied people aged 18 to 84 years for 8 years. They found that the participants' body weight increased during the observed period. However, weight gain was lower in the group of men who increased their physical activity compared to inactive individuals; the same changes occurred in women (De Munter *et al.* 2015). In our group, we observed statistically significant differences in lifestyle (in overall, positive and negative scores) in groups of different sex. Only the negative score was significantly dependent on BMI.

Martinez-Avila *et al.* (2020) reported that a sedentary lifestyle was inversely associated with hunger attacks and binge eating. At the same time, they stated that time spent doing physical activity was directly linked to binge eating and emotional eating. In our research,

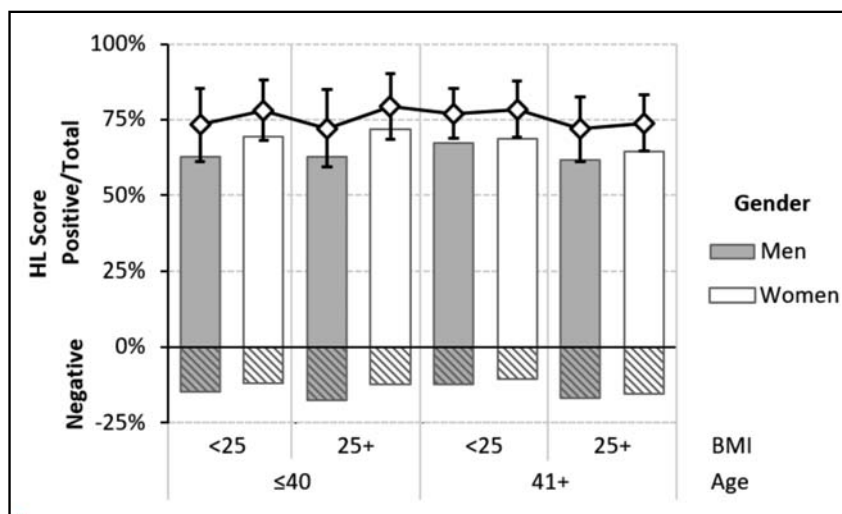


Fig. 1. Mean HL scores of the 8 subgroups based on sex, age and BMI. All scores are transformed to a relative scale (theoretical score minimum and maximum are set to 0 and 100%, respectively). For clarity, only the Total HL score (line graph with diamonds) is accompanied with error bars (SD).

we did not directly examine binge eating and emotional eating, but 72% of people with higher BMI do sports regularly, while 51% of them at least 30 minutes a day; despite regular physical activity, these respondents had a higher body weight, which could be related to the fact that they were less able to control their diet and may more often experienced binge eating or emotional eating.

According to Kanesarajah *et al.* (2018) physical activity can moderate the adverse effect of overweight and obesity on quality of life in middle-aged women – women with high physical activity and obesity showed a similar quality of life to women with normal weight or overweight with low physical activity; while overweight women with moderate physical activity showed a similar quality of life to women with normal weight and low physical activity.

Cassidy *et al.* (2017) did a cross-sectional study that focused on lifestyle and found that overweight and obese adults were less physically active compared to those of adequate body weight. This is also in accordance with our study. In lower BMI group – 82% are regularly active in sports, and 71% of them had at least 30 min/day regular physical activity (58% from lower BMI group). In higher BMI group – 72% are regularly active in sports, while 71% of them had at least 30 min/day of regular physical activity (51% from higher BMI group). Also Roda *et al.* (2016) states that people who spend their free time actively (i.e. moving), and who consume more vegetables, which they describe as part of a healthy lifestyle, have a lower prevalence of being overweight.

In our case, we observed more significant differences in the assessment of physical fitness level. In a lower BMI group – 64% described their fitness level as excellent or good and only 8% as sufficient or poor. In a higher BMI group – 30% described their fitness level as excellent or good and 35% as sufficient or poor. The rest of both groups consider their fitness level as averaged.

Roda *et al.* (2016) further reported that a higher prevalence of overweight occurs among adults with a lower education, which is in accordance with our findings. Among individuals with overweight or obesity, 13% of respondents had achieved primary education, 63% secondary education and the rest (24%) had tertiary education. In group with lower BMI – 6% achieved primary education, 59% secondary, while 35% achieved tertiary education.

According to Puciato and Rozpara (2020) students have more often physiological BMI (85.4%), in comparison to different types of works, e.g. manual work, office work etc. Among our respondents there were a total of 75 students (i.e. 23% of the entire research group), while 63% of them had physiological BMI, 37% were overweight or obese. Puciato and Rozpara (2020) further reported that among the unemployed, more than half of the respondents were of normal weight. It is

not in accordance to our findings (our sample of unemployment was small).

De Munter *et al.* (2015) reported that low alcohol intake was associated with lower weight gain, but only in men. In lower BMI group were 69% occasional alcohol consumers and 29% abstainers. In higher BMI group were 55% abstainers and 44% occasional consumers. Our findings would suggest that abstinence could be a factor that increases body weight. The reason could also be, for example, more frequent consumption of sweetened beverages, that can replace alcohol on various occasions. Kim and Lee (2021) pointed to an association between the consumption of non-alcoholic "soft" drinks and the prevalence of obesity compared to the consumption of non-alcoholic non-sweetened beverages. They further stated that consumption of "soft" drinks is associated with a subjectively worse health status (Kim and Lee, 2021).

Another risk factor is smoking. De Munter *et al.* (2015) found that both men and women who quit smoking during the observation period showed a weight gain. Our data showed that in higher BMI group are more often former smokers (54%), than in lower BMI group (24%).

Audrain-McGovern and Benowitz (2011) focused on the effect of smoking and nicotine on body weight. Cigarettes can partially replace the need to eat, and nicotine can suppress the feeling of hunger. After quitting smoking, physical activity usually does not increase significantly, people reach a positive energy balance and their body weight increase (Audrain-McGovern and Benowitz, 2011). The quitting smoking reduces the risk of cardiovascular disease (CVD), but weight gain is one of the risk factors for CVD. According to Pandey *et al.* (2017) the risk of heart failure was higher the higher BMI value of individuals. Authors stated that the risk of heart failure decreases with increasing physical activity (Pandey *et al.* 2017).

CONCLUSION

In our research we focused on the assessment of lifestyle in connection with BMI. We found that young women (18–41 years) with a higher BMI (BMI \geq 25 kg/m²) and older men (42–65 years) with a higher BMI (BMI \geq 25 kg/m²) are significantly different from each other in terms of overall lifestyle. Those with a lower BMI have a healthier lifestyle than those who are overweight or obese. The overall healthy lifestyle score is dependent on sex, as are the positive and negative scores. The negative lifestyle score is also dependent on BMI.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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