

Assessment of Negative Factors Affecting the Intestinal Microbiota in People with Excessive Body Mass Compared to People with Normal Body Mass [†]

Karolina Osowiecka ^{1,*}, Natalia Pokorna ² and Damian Skrypnik ³

¹ Department of Dietetics, Institute of Human Nutrition Sciences, Warsaw University of Life Sciences, 02-776 Warsaw, Poland

² Institute of Human Nutrition and Dietetics, Faculty of Food Science and Nutrition, Poznan University of Life Sciences, 60-624 Poznan, Poland; pokorna.natalia@wp.pl

³ Department of Treatment of Obesity, Metabolic Disorders and Clinical Dietetics, Poznan University of Medical Sciences, 60-569 Poznan, Poland

* Correspondence: osowiecka.karolina@wp.pl

[†] Presented at the The 1st International Electronic Conference on Nutrients—Nutritional and Microbiota Effects on Chronic Disease, 2–15 November 2020; Available online: <https://iecn2020.sciforum.net/>.

Published: 30 October 2020

Abstract: Rationale: Intestinal microbiota plays a significant role in the human body. A range of negative factors may lead to dysbiosis, which results in many diseases (e.g., cancer) and metabolic disorders. It was shown that people with a body mass index (BMI) of ≥ 25 kg/m² present diminished microbial diversity. Additional negative factors such as stress, the use of non-steroidal anti-inflammatory drugs (NSAID) and proton pump inhibitors (PPI) may result in greater dysbiosis compared to people with normal body mass. The aim of the study was to compare the incidence of negative factors affecting the intestinal microbiota in people with excessive body mass vs. people with normal body mass. Methods: The study involved volunteers aged 18–65 years: 582 people with normal BMI (18.5–24.99 kg/m²) and 538 people with BMI ≥ 25 kg/m². The study was conducted using the author's survey by the Computer-Assisted Web Interviewing method. The survey included the questions on sociodemographic features, level of physical activity, frequency of smoking, and stress. Frequency of NSAID and PPI use was also investigated. BMI was used to assess nutritional status. For statistics the Fisher test was implemented. *p*-Value < 0.05 was considered significant. Results: Women predominated in the study ($p < 0.0001$). People with normal BMI had a significantly higher level of physical activity ($p < 0.0001$) and smoked less ($p = 0.0356$). People with excessive body mass were less likely to report illness ($p = 0.0004$), but more often they took PPI ($p = 0.0337$). Conclusions: People with BMI ≥ 25 kg/m² present more factors which may result in dysbiosis and lead to dysbiosis-related health problems in future compared to people with normal BMI.

Keywords: dysbiosis; excessive body mass; health effects; microbiota; obesity

1. Introduction

It is estimated that the number of microorganisms in the digestive tract is over 10^{14} CFU (colony forming units), forming microbiota. The intestinal microbiota plays a significant role in the human body, for example by shaping the intestinal epithelium, protecting against pathogens, and regulating the host's immunity [1]. A range of negative factors may promote dysbiosis, which leads to many diseases (e.g., cancer) and metabolic disorders [2]. It has been shown that people with a body mass index (BMI) of ≥ 25 kg/m² present diminished microbial diversity. Additional negative factors such as alcohol consumption [3], stress [4], sedentary lifestyle [5], and smoking cigarettes [6] may decrease

the quality of microbiota. Also use of non-steroidal anti-inflammatory drugs (NSAID) [7] and proton pump inhibitors (PPI) [8] may result in greater dysbiosis. The mechanism linking the microbiota quality and PPIs/NSAIDs is not fully understood. PPIs are believed to reduce the amount of hydrochloric acid in the stomach, which allows the entry of harmful bacteria [9]. The use of NSAIDs may reduce the composition of the gut microbiota and mainly cause an overgrowth of gram-negative and anaerobic bacteria. Thus, it weakens the mucosal defenses and increases the susceptibility to intestinal damage [10]. The aim of the study was to compare the incidence of negative factors affecting the intestinal microbiota in people with excessive body mass vs. people with normal body mass.

2. Materials and Methods

The survey was attended by Polish volunteers aged 18–65 years. The subjects ($n = 1120$) were divided into two groups: subjects with normal BMI “N-BMI group” (BMI 18.5–24.99 kg/m²) ($n = 582$) and with excessive BMI „E-BMI group” (BMI ≥ 25 kg/m² = pre-obesity and obesity) ($n = 538$) (according to the criteria recognized by WHO, World Health Organization) [11]. The study was conducted with the use of the original survey using the Computer-Assisted Web Interviewing method. The CAWI method is a popular method of data collection. It is characterized by the creation of an online research questionnaire that is displayed to interested respondents. It is an easy and cheap way to reach a research group who will complete the survey on their own [12]. The surveys were collected between February and June 2020. The questionnaire included questions on sociodemographic characteristics, level of physical activity, frequency of smoking, and stress. Also the frequency of use of NSAIDs and PPIs was examined. Statistica for Windows 10.0 software (StatSoft, Kraków, Poland) was used to analyze the results. For statistics the Fisher test was implemented. p -Value < 0.05 was considered significant.

3. Results

Both groups aged 18–65 were dominated by women ($p < 0.0001$). The mean age for the N-BMI group was 32.6 ± 8.6 years, and for the group with excessive body weight 35.97 ± 9.6 years. The main age in the groups differed significantly ($p < 0.0001$). The participants of the research declared an average or good financial situation. This feature differed significantly between the groups ($p = 0.0137$) (Table 1).

Table 1. Characteristics of group ($n = 1120$).

Characteristics of Group	E-BMI Group ($n = 538$) (%)	N-BMI Group ($n = 582$) (%)
Gender		
Female	474 (88.1)	553 (95)
Male	64 (11.9)	29 (5)
Age (years)		
18–24	50 (9.3)	101 (17.4)
25–34	218 (40.5)	279 (47.9)
35–44	169 (31.4)	149 (25.6)
45–54	72 (13.4)	36 (6.2)
55–65	29 (5.4)	17 (2.9)
Education level		
Primary	5 (0.9)	7 (1.2)
Lower secondary	24 (4.5)	18 (3.1)
Upper secondary	136 (25.3)	114 (19.6)
Student	45 (8.4)	71 (12.2)
Higher	308 (57.2)	348 (59.8)
PhD Student	4 (0.7)	5 (0.9)
PhD or higher	16 (3)	19 (3.2)
Economic situation		

Very Bad	8 (1.5)	3 (0.5)
Bad	13 (2.4)	20 (3.4)
Moderate	253 (47)	232 (39.9)
Good	214 (39.8)	282 (48.5)
Very good	50 (9.3)	45 (7.7)

The N-BMI group differed significantly from the overweight group in the range of assessing own level of physical activity ($p < 0.0001$), and frequency of smoking ($p = 0.0356$) (Table 2). Most often, participants declared moderate physical activity, almost 50% had a sedentary level (E-BMI group) or approximately 30% (N-BMI group). In contrast, the frequency of alcohol consumption and stress were similar between the groups. The presence or the lack of diagnosis of the disease also significantly differed and the N-BMI group was diagnosed in approximately 11%. The use of NSAIDs was declared by 456 people (E-BMI group) and 481 (N-BMI group). In both groups, the most common use of NSAIDs was from less than once a month to several times a month. There was no significant difference between the groups ($p = 0.3737$) in NSAIDs use. On the other hand, PPI drugs were taken by 140 people in E-BMI group and 110 in N-BMI group. PPIs were most often taken once a day. In this range significant difference was noticed ($p = 0.0050$) (Table 2).

Table 2. Selected factors influencing the microbiota (n = 1120).

	E-BMI (n = 538) (%)	N-BMI (n = 582) (%)	p-Value
Level of physical activity			
Sedentary	239 (44.4)	177 (30.4)	<0.0001
Moderate	273 (50.8)	345 (59.3)	
High	26 (4.8)	60 (10.3)	
Cigarette smoking			
Not smoking	324 (60.2)	393 (67.6)	0.0356
Has smoked in the past	92 (17.1)	81 (13.9)	
<5 cigarettes a day	30 (5.6)	28 (4.8)	
5–20 cigarettes a day	83 (15.4)	78 (13.4)	
>20 cigarettes a day	9 (1.7)	2 (0.3)	
Alcohol			
No	184 (34.2)	220 (37.8)	0.4440
Less often than once a week	213 (39.6)	237 (40.7)	
1–2 times a week	106 (19.7)	94 (16.2)	
3–4 times a week	27 (5)	24 (4.1)	
5 times a week or more	8 (1.5)	7 (1.2)	
Stress			
No	22 (4.1)	24 (4.1)	0.2259
Less often than once a week	104 (19.3)	137 (23.5)	
1–2 times a week	148 (27.5)	174 (29.9)	
3–4 times a week	130 (24.2)	118 (20.3)	
5 times a week or more	134 (24.9)	129 (22.2)	
Diagnosis of the disease			
Not diagnosed	350 (60.1)	289 (49.7)	0.0004
Diagnosed	232 (39.9)	293 (50.3)	
NSAID drugs			
I do not take	82 (15.2)	101 (17.4)	0.2580
Once a month or less	194 (36.1)	223 (38.1)	
Few times a month	171 (31.9)	175 (30.1)	
Once a week	25 (4.6)	26 (4.5)	
Few times a week	43 (8)	33 (5.7)	

Once a day	18 (3.3)	12 (2.1)	0.0337
More than once a day	5 (0.9)	12 (2.1)	
PPI drugs			
I do not take	398 (74)	472 (81.1)	
Once a month or less	40 (7.4)	32 (5.5)	
Few times a month	27 (5)	21 (3.6)	
Once a week	4 (0.7)	2 (0.3)	
Few times a week	12 (2.2)	11 (1.9)	
Once a day	53 (10)	34 (5.9)	
More than once a day	4 (0.7)	10 (1.7)	

4. Discussion

In a Polish study by Słaby et al. assessing, inter alia, the intake of NSAID drugs and knowledge about probiotics, the number of women compared to men also dominated (79.4% versus 20.6%). Most people were over 61 years of age (28.9%) and between 26–40 years of age (23.5%)—thus, older than in the own study [7]. A study by Bressa et al. showed differences in the profile of the gut microbiota between women with an active lifestyle compared to a sedentary lifestyle. They proved that performing physical exercise for at least 3 h a week resulted in a greater number of pro-health bacterial species, including *Faecalibacterium prausnitzii*, *Akkermansia muciniphila* [5]. Referring to smoking cigarettes - Lee et al. found that microbiota diversity differed between current smokers and non-smokers in a cross-sectional population study ($p = 0.017$) and smokers ($p = 0.011$). The authors found no significant difference between non-smokers and previous cigarette smokers [6]. Moderate alcohol consumption, including short-term consumption, may contribute to dysbiosis (e.g., by reducing the number of *Lactobacillus*) in rats [3]. There are several factors by which stress can adversely affect the microbiota. These include, among others: change in gastrointestinal motility and reduced digestive activity, and thus the availability of the substrates. Also, the stress changes immune function, causes oxidative stress and inflammation [4]. In the study by Słaby et al., 31% of the respondents declared taking NSAIDs, which is lower than in the own study- in both groups [7]. In a study by Imhann et al., among 1815 participants, only 211 (11.6%) used PPIs, which is less than in the own study. In the group of this 211 patients, the authors observed a significant increase in the number of bacteria: *Enterococcus*, *Streptococcus*, *Staphylococcus*, and potentially pathogenic *Escherichia coli* [8].

5. Conclusions

People with BMI ≥ 25 kg/m² present more factors which may result in dysbiosis and lead to dysbiosis-related health problems compared to people with normal BMI.

Author Contributions: Conceptualization, K.O., N.P. and D.S.; methodology, K.O., N.P. and D.S.; software, D.S.; validation, K.O. and N.P.; formal analysis, K.O., N.P. and D.S.; investigation, K.O. and N.P.; data curation, K.O.; writing—original draft preparation, K.O. and N.P.; writing—review and editing, D.S.; visualization, K.O. and N.P.; supervision, D.S.; project administration, K.O. All authors have read and agreed to the published version of the manuscript.

Acknowledgments: The authors kindly thank all respondents for their participation in the study.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Thursby, E.; Juge, N. Introduction to the human gut microbiota. *Biochem. J.* **2017**, *474*, 1823–1836.
2. DeGruttola, A.K.; Low, D.; Mizoguchi, A.; Mizoguchi, E. Current Understanding of Dysbiosis in Disease in Human and Animal Models. *Inflamm. Bowel Dis.* **2016**, *22*, 1137–1150.
3. Kosnicki, K.L.; Penprase, J.C.; Cintora, P.; Torres, P.J.; Harris, G.L.; Brasser, S.M.; Kelley, S.T. Effects of moderate, voluntary ethanol consumption on the rat and human gut microbiome. *Addict. Biol.* **2019**, *24*, 617–630.

4. Karl, J.P.; Hatch, A.M.; Arcidiacono, S.M.; Pearce, S.C.; Pantoja-Feliciano, I.G.; Doherty, L.A.; Soares, J.W. Effects of Psychological, Environmental and Physical Stressors on the Gut Microbiota. *Front. Microbiol.* **2018**, *9*, 2013.
5. Bressa, C.; Bailén-Andrino, M.; Pérez-Santiago, J.; González-Soltero, R.; Pérez, M.; Montalvo-Lominchar, M.G.; Maté-Muñoz, J.L.; Domínguez, R.; Moreno, D.; Larrosa, M. Differences in gut microbiota profile between women with active lifestyle and sedentary women. *PLoS ONE* **2017**, *12*, e0171352.
6. Lee, S.H.; Yun, Y.; Kim, S.J.; Lee, E.J.; Chang, Y.; Ryu, S.; Shin, H.; Kim, H.L.; Kim, H.N.; Lee, J.H. Association between Cigarette Smoking Status and Composition of Gut Microbiota: Population-Based Cross-Sectional Study. *J. Clin. Med.* **2018**, *7*, 282.
7. Słaby, D.; Szewczyk, S.; Beberok, A.; Wrześniok, D. The role of protective agents in pharmacotherapy—Assessment of patients awareness [Rola preparatów osłonowych w farmakoterapii—Ocena świadomości pacjentów]. *Farm Pol.* **2019**, *75*, 591–598.
8. Imhann, F.; Bonder, M.J.; Vila, A.V.; Fu, J.; Mujagic, Z.; Vork, L.; Tigchelaar, E.F.; Jankipersadsing, S.A.; Cenit, M.C.; Harmsen, H.J.; et al. Proton pump inhibitors affect the gut microbiome. *Gut* **2016**, *65*, 740–748.
9. Macke, L.; Schulz, C.; Koletzko, L.; Malfertheiner, P. Systematic review: The effects of proton pump inhibitors on the microbiome of the digestive tract—Evidence from next-generation sequencing studies. *Aliment. Pharmacol. Ther.* **2020**, *51*, 505–526.
10. Maseda, D.; Ricciotti, E. NSAID-Gut Microbiota Interactions. *Front. Pharmacol.* **2020**, *11*, 1153.
11. Database on Body Mass Index. Available online: <http://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthy-lifestyle/body-mass-index-bmi> (accessed on 16 October 2020).
12. Sowa, P.; Pędziniński, B.; Krzyżak, M.; Maślach, D.; Wójcik, S.; Szpak, A. The Computer-Assisted Web Interview Method as Used in the National Study of ICT Use in Primary Healthcare in Poland—Reflections on a Case Study. *Stud. Log. Gramm. Rhetor.* **2015**, *43*, 137–146.

Publisher’s Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



© 2020 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).