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Eating Patterns in Relation to Anthropometrics and Blood Pressure among Overweight Adults Within a Swedish RCT

– A cross-sectional study

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Abstract

Background

The pattern of how and when food is consumed possibly play a role in weight management and health but is less studied compared to effects related to food content.

Objective

To describe eating patterns and investigate the relation to body mass index (BMI), waist circumference and blood pressure.

Methods

Overweight residents aged 18-70 years with a BMI between 27-45 kg/m^2, participating in a baseline health survey in an ongoing randomized controlled trial on weight reduction were included. Eating patterns were assessed by questionnaire and categorized on number of eating occasions per day, number of snacks per day, number of meals with cooked food per day and the timing of the largest meal. Anthropometric measures were taken by study nurses. Cross-sectional analysis of baseline data was performed.

Results

Participation rate was 88% (n=176). Mean age was 55 years, 79% female and mean BMI 34kg/m^2. The most common eating pattern was consuming five meals per day, including breakfast, two cooked meals and two snacks. Women reported more eating occasions than men; >3/day (93% vs 78%, p=0.01) and >1snack/day (79%vs 61%, p=0.03). Older participants (≥55years) reported fewer meals with cooked foods and more snacks per day. Older participants rated their eating habits as "good" to a greater degree than younger participants. No relation was found between eating patterns and BMI or waist circumference. Participants eating two, as opposed to one, cooked meal per day had a lower systolic blood pressure (134 vs 140 mmHg, p=0.02) and those with good self-rated eating habits had a lower diastolic blood pressure (82 vs 84 mmHg, p=0.03).

Conclusions

Our results indicate that eating patterns among overweight residents differs between sexes and according to age. No relation between eating patterns and body measures were seen, apart from between number of cooked meals and blood pressure.

Populärvetenskaplig Sammanfattning

Hur vi äter, när vi äter och vad vi äter spelar stor roll i hur vi mår samt för vår förmåga att kunna hålla en stabil vikt. Utöver det vi stoppar i munnen påverkar mönstret med vilket vi äter vår hälsa. Måltidsmönster innefattar tidpunkten för matintag samt vilken typ av måltid som intas (frukost, mellanmål eller tillagad mat).

I denna studie studerades måltidsmönster hos 176 vuxna personer med övervikt. Detta innefattade hur många mål samt mellanmål som intogs en typisk dag, om deltagarna åt frukost eller inte, hur många av måltiderna som innehöll lagad mat samt när på dagen som den största måltiden förtärdes. Detta relaterades sedan till olika kroppsmått såsom BMI, midjemått samt blodtryck för att se om det kunde finnas något samband mellan måltidsmönster och dessa kroppsmått.

Resultaten visade på att det vanligaste ätmönstret var att äta fem måltider per dag, inkluderat frukost, två huvudmål samt två mellanmål. Kvinnor åt >3 måltider per dag samt >1 snacks dagligen i högre utsträckning än vad män gjorde. Den äldre åldersgruppen (>55 år) tenderade att äta färre stora måltider med lagad mat än den yngre åldersgruppen (≤ 55år). Den äldre åldersgruppen åt dock fler mindre måltider (mellanmål) i större utsträckning än de yngre deltagarna. Det enda sambandet mellan måltidsmönster och kroppsmått som sågs var mellan antalet måltider med lagad mat per dag och blodtryck där de som åt två måltider med lagad mat per dag hade ett lägre blodtryck än de som istället åt endast ett mål med lagad mat per dag.

Sammanfattningsvis kan det konstateras att bland de deltagande i studien så skilde sig måltidsmönstret mellan kvinnor och män samt mellan medverkande > 55år samt ≤ 55år. Förutom sambandet mellan antalet måltider med lagad mat och blodtryck sågs få samband mellan måltidsmönster och kroppsmått.

Introduction

The increasing prevalence of overweight and obesity worldwide is a major health challenge. Overweight is defined as body-mass index (BMI) ≥ 25 to <30 kg/m^2 and obesity as BMI ≥ 30 kg/m^2. The number of overweight adults is rapidly increasing and in 2013 it was estimated that 37% of adults were overweight. The prevalence of children and adolescents with overweight is also rising, as well as the prevalence of overweight and obesity in developing countries (1). Management of obesity is very expensive and is contributing to raising costs for health care (2).

Apart from macronutrient composition and the quality of meals consumed, it has been shown that other aspects of the human eating behavior does have an impact on health and weight control. These include the timing and size of meals, the number of meals consumed in a day, as well as whether breakfast is consumed or not. The phrase "eating patterns" describes how the different meals and snacks are distributed over for example a day and what type of meals are being consumed (main meal, breakfast or snack) while "eating habits" in addition to the distribution of the meals also include the nutritional content of the food being consumed. It has been shown that these factors play a role in changes in BMI and other health outcomes (3-6). Convincing scientific evidence is lacking when it comes to the timing, size and optimal number of meals.

For many years increased eating frequency (increased snacking) has been recommended as a strategy for weight loss and being able to maintain a healthy body weight. Some studies have shown that people who snack have a greater appetite control and are less likely to be obese (5, 7). In a study on eating patterns and obesity conducted in 2003, healthy participants visited a medical clinic at baseline and every 3 months over the year to come. During each of these 3 month periods weight was measured. In addition to this the participants had to do three 24-hour dietary recall every three months. These days were selected at random and food intake was assessed on two weekdays and one day during the weekend. In total 15 24-hour dietary recalls were made for each participant throughout the duration of the study (5). This way of measuring eating habits by randomly selecting two weekdays and one day of the weekend has been used in other studies (8). These dietary recalls were then analyzed based on macronutrient composition as well as number of eating occasions. An eating episode was classified as an event including at least 50kcal with at least 15min time interval between two

eating occasions. Results implied that an increased meal frequency was associated with a decreased risk of obesity (5).

However, other more recent larger studies have shown that an increased number of eating occasions leads to weight gain (4, 6). In 2017 a study on meal frequency and timing of meals was conducted using data from over 50 000 healthy adults (4). Exposure variables included the number of meals per day and consumption of breakfast, among others. These variables were then related to change in BMI per year. When included the participants had to fill in a self-administered Food Frequency Questionnaire (FFQ) at baseline including questions on the timing of the largest and smallest meals and the number of snacks consumed per day. The participants were then sent a biennial form for a total of 4 times, containing questions on weight and questions related to food-intake. Conclusions were that consuming fewer meals per day, snacking less, eating breakfast as well as consuming the biggest meal of the day at breakfast could be effective ways to prevent weight-gain over time (4). However, as the participants were members of an independent church and are to be considered a rather heterogenous group, it is not certain that this is representative or applicable on individuals with overweight or obesity.

There are also results indicating that snacking between meals increases the risk for type 2 diabetes (T2D)(9). In 1986, 52 000 male health professionals were included in a study on eating patterns and the risk of type 2 diabetes. At baseline the participants had to fill in a FFQ on what they had been eating over the last year. Every 4-years a new FFQ containing questions about diet was sent out for the participants to fill in. The FFQ sent out in 1992 included the question " How many times a day do you eat?". There were predefined eating windows to choose from. Breakfast, lunch and dinner was considered meals. Other eating episodes were considered snacks. Some conclusions were that men who ate 3 times per day had a lower probability of developing T2D in comparison with men eating 1-2 times per day which were linked to an elevated risk of developing T2D. Snacking beyond the 3 main meals was connected with an increased risk of T2D, however these associations were diminished after adjusting for BMI (9).

Several studies has proven the many benefits related to breakfast eating. Consuming breakfast has been associated with better weight control, decreased risk for T2D and a lower risk of developing coronary heart disease (4-6, 9, 10).

The effect of eating pattern, meal timing and meal frequency in relation to body weight has been studied more and more as of recent. There are studies stating a correlation between eating patterns and BMI, however there is no consensus as to whether an increased or reduced meal frequency leads to better weight management (4-7). Apart from BMI as an indicator of overweight and obesity, waist circumference is also an important indicator of health. There is a positive correlation between waist circumference and BMI (11). Therefore the association between eating patterns and waist circumference is supposed to be the same as the relation between eating patterns and BMI. Associations between eating patterns and blood pressure is rarely studied. A study from 2019 found an inverse association between snack frequency and blood pressure (12). However this association disappeared after adjusting for other dietary factors.

In an ongoing randomized controlled trial (RCT) with an intervention for weight loss, eating patterns and body measurements such as BMI, waist circumference and blood pressure was assessed at baseline. The intervention was an educative concept for weight loss called “Våga vara mätt” focusing on eating for satiety and normal weight, food content and effects on blood sugar and how to have a healthy relationship with food.

Aim

In this cross-sectional study we sought to classify and describe eating patterns in overweight participants enrolled in an intervention study and investigate eating patterns in relation to BMI, waist circumference, blood pressure and the participants self-rated eating habits.

Subjects and methods

Subjects

Recruitment of participants was made through media ads and websites in Kronoberg and Kalmar Län. Those interested were interviewed via telephone by a project-nurse based on a protocol regarding inclusion- and exclusion criteria. Two hundred (n=200) Swedish speaking residents aged 18-70 years with a BMI 27-45 kg/m^2 were included in the study. The exclusion criteria were as follows: multiple food allergy, insulin-treated diabetes, severe mental illness, severe liver or kidney disease, heart failure grade 3-4 or other serious general disease.

Data collection

At a baseline health examination all participants filled in a questionnaire about lifestyle, eating habits, quality of life, health and illness. Height, weight and waist measurements were taken by a study nurse. Systolic and diastolic blood pressure were also taken using a manual blood pressure monitor after sitting rest.

Eating patterns were assessed by an open question where participants were asked to fill in everything they eat and drink in a typical day. The open question is presented in Figure 1. A typical day of eating were split into six different "windows" of eating: early morning, late morning, midday, afternoon, evening and night. The participants were asked to write everything they ate within each of these "eating-periods". Self-rated eating habits were assessed by a multiple-choice question with four answer options: "Very good", "Good", "Bad" and "Very bad". The questions were answered on paper forms and were later coded and transferred into a database by the author.

For our study we used an open question from the original questionnaire together with taken body measurements and blood pressure. The most common method used to assess the diet and/or eating patterns of a single individual or on a group level is a food frequency questionnaire (FFQ)(13). This can be done in a closed FFQ were the participants are given options on potential eating habits and has to choose which option that best fits their way of eating (14), or in an open FFQ where they get to manually fill in what they eat or describe what they eat in a structured interview (15).

8. Vad äter och dricker du en vanlig vardag? *Skriv upp allt du stoppar i munnen under dagen. Ange typ av mat/dryck tex. 4 ostmackor, 8 köttbullar, 3 stora potatis, 2dl sås, 1 msk gele och ärtor, 1 äpple, 200g chokladkaka, 100 g smågodis, 2 glas juice, 1 starköl, kaffe med eller utan socker/mjölk/grädde etc.*

Tid	Äter	Dricker
Morgon		
Förmiddag		
Mitt på dagen		
Eftermiddag		
Kväll		
Natt		

Figure 1. Questionnaire item assessing eating habits including "eating-windows" within which participants were asked to write down a detailed description of everything they ate in a typical day.

Categorization of eating pattern

Breakfast, cooked lunch and cooked dinner were considered main meals while eating in between meals or replacing meals with non-cooked food were considered snacking. This is a common way to assess meal patterns and a similar method has been used in other studies (4, 9). Coded variables were number of eating occasions, timing of the largest meal, consumption of breakfast as well as number of cooked meals and snacks.

Breakfast was considered as consuming food within either of the first two eating-windows (consuming food before midday). The number of meals were counted by summarizing the number of eating windows in which food had been consumed. One eating window could include two separate eating occasions. An eating window was coded as two separate eating occasions if the food consumed was written far apart from one another within the window or if the participant specified the time of two different eating occasions. If the food-components of the main meals (lunch/dinner) was not specified and instead documented as either "lunch" or "dinner" by the participant, it was registered as a cooked meal. If options of both cooked food and non-cooked food were given by the participant in one eating window, the first option given was considered the most common and was therefore registered. Eating a pre-packaged meal or eating out were classified as a cooked meal. As many participants wrote the timing of the food being consumed, the timing of the meal was used to classify the type of main meal being consumed. Lunch was considered as a cooked meal consumed between 12:00 and 15:00 and dinner was considered being a cooked meal consumed between 15:00 and 21:00. If instead of consuming a cooked meal during lunch- or dinner-time the participant consumed a lighter non-cooked meal, such as an open sandwich or porridge, it was considered a snack and not a main meal.

In order for a meal to be considered as a main meal (lunch or dinner) it had to include cooked foods and be consumed within the time-windows previously mentioned. If consuming cooked foods at both lunch and dinner, the main meals were considered similar in size. A cooked meal was always considered as being a larger meal than a non-cooked meal. Any eating occasion that was not breakfast or classified as a main meal was considered a snack.

Statistical analysis

All statistical analyses were done with SPSS 27. Tests of normality was conducted visually using histograms. Categorial data was reported as number (n) and proportion (%) and continuous data was reported as mean and standard deviation (SD) or median with interquartile range (IQR: Q1-Q3) using descriptive statistics. Two tailed *t*-test was used to compare different sets of eating patterns to BMI, waist circumference and systolic and diastolic blood pressure. Chi-square test was used to compare eating patterns between men and women, age groups and self-rated eating habits. Self-rated eating habits was for presenting purposes recoded into a binary variable with only two categories: "Good" or "Bad". A p- value <0.05 was considered significant.

Ethical considerations

Participation in the intervention study “Våga vara mätt” was not considered to be of any medical risk. Instead, a health benefit for the participants in the form of weight loss and better well-being was to be expected. Counseling as well as the sampling of blood-tests was done by experienced staff, although collection of blood tests could be considered unpleasant. Participation in this study could be perceived as a violation of privacy. However, participation was voluntary and the participants could choose to leave the study at any time. The results would be presented at a group level and no single participant would be identifiable, which leads to a less intrusion of privacy than if results would be presented at an individual level. The intervention study was approved by the Ethics Review Board in Linköping, Dnr: 2014/231-31.

Results

In total 176 subjects participated in the baseline survey. The participation rate was 88%, The mean age of the participants was 55 ± 10 years (Table 1). Mean BMI was 34 ± 5 kg/m^2.

Table 1. Characteristics of the study population (n=176).

Variables	Mean	SD	Median	IQR	Range
Age, y	55	10	56	50-62	25-70
BMI kg/m^2	34	5	33	60-66	26-53
Blood pressure, mmHg					
Systolic	136	16	135	130-142	110-220
Diastolic	83	8	80	80-85	60-120
Waist circumference, cm	104	12	104	87-110	77-148
Number of eating occasions/d	6	1	5	4-5	2-6
Number of snacks/d	2	1	2	2-3	0-4
Number of meals with cooked food/d	2	1	2	2-3	0-2

The most common eating pattern was consuming food five times per day (Table 2). This included eating breakfast followed by a snack later in the morning. Lunch and dinner mainly consisted of cooked foods. Consuming a second snack in the afternoon was also a part of the most typical eating pattern. Almost 25% of participants consumed some sort of snack later in the evening, after having dinner. Female participants were overrepresented (79%) compared to males (21%). A majority of partakers rated their eating habits as being “Very good” or “Good” (61% total). All but two participants consumed breakfast in a typical day.

Table 2. Characteristics of the study population (n=176)[1]

Variables	Values
Sex, n	
Female	140 (79)
Male	36 (21)
Number of eating occasions/d	
2	1 (1)
3	17 (10)
4	54 (31)
5	72 (41)
6	32 (18)
Number of snacks/d	
0	12 (7)
1	31 (18)
2	75 (43)
3	51 (29)
4	7 (4)
Number of meals with cooked food/d	
0	1 (1)
1	65 (37)
2	110 (63)
Consumption of breakfast	
Yes	174 (99)
No	2 (1)
Largest meal consumed/d	
Lunch	50 (28)
Dinner	29 (17)
Two large meals	96 (55)
No cooked meal	1 (1)
Self reported eating habits	
Very good	1 (1)
Good	102 (60)
Bad	55 (33)
Very bad	11 (7)

1 All values are n (%) unless otherwise indicated

In Table 3 participant characteristics by total number of eating occasions per day are shown. Participant characteristics by total number of snacks consumed per day are displayed in Table 4. No relations between these eating patterns and BMI, waist circumference and blood pressure (systolic and/or diastolic) was found.

Table 3. Participant characteristics by total number of eating occasions per day (n=176).

Variables	≤ 3 meals/d[1]	> 3 meals/d	P-value[2]
n	18	158	
BMI (kg/m^2)	34 ± 5	34 ± 5	0.77
Waist circumference (cm)	107 ± 14	104 ± 11	0.35
Blood pressure, systolic (mmHg)	140 ± 17	136 ± 16	0.34
Blood pressure, diastolic (mmHg)	86 ± 9	83 ± 8	0.16

1 Mean ± SD (all such values)

2 P-value is significant ≤ 0.05. Statistical analysis made using two tailed t-test.

Table 4. Participant characteristics by total number of snacks consumed per day (n=176).

Variables	0-1 snacks/d[1]	> 1 snacks/d	P-value[2]
n	43	133	
BMI (kg/m^2)	35 ± 6	34 ± 4	0.27
Waist circumference (cm)	107 ± 12	104 ± 11	0.10
Blood pressure, systolic (mmHg)	135 ± 14	137 ± 17	0.59
Blood pressure, diastolic (mmHg)	84 ± 8	83 ± 8	0.57

1 Mean ± SD (all such values)

2 P-value is significant ≤ 0.05. Statistical analysis made using two tailed t-test.

There was a significant difference in systolic blood pressure between participants eating one cooked meal per day and participants eating two cooked meals per day (Table 5). Eating two cooked meals per day was associated with a lower systolic blood pressure as compared to eating one cooked meal per day.

Table 5. Participant characteristics by total number of meals with cooked food consumed per day (n=175).

Variables	1 meal/d[1]	2 meals/d	P-value[2]
n	65	110	
BMI (kg/m^2)	34 ± 5	34 ± 5	0.49
Waist circumference (cm)	105 ± 11	104 ± 12	0.64
Blood pressure, systolic (mmHg)	140 ± 18	134 ± 14	**0.02**
Blood pressure, diastolic (mmHg)	83 ± 10	83 ± 7	0.73

1 Mean ± SD (all such values)

2 P-value is significant ≤ 0.05. Statistical analysis made using two tailed t-test.

A significant difference was seen in diastolic blood pressure in relation to self-rated eating habits, where those rating their eating habits as "Good" had a significantly lower diastolic blood pressure than participants rating their eating habits as "Bad"(p = 0.03) (Table 6).

Table 6. Participant characteristics by self-rated eating habits (n=169).

Variables	Good[1]	Bad	P-value[2]
n	103	66	
BMI (kg/m^2)	34 ± 5	34 ± 5	0.35
Waist circumference (cm)	105 ± 12	105 ± 12	0.93
Blood pressure, systolic (mmHg)	135 ± 15	138 ± 17	0.32
Blood pressure, diastolic (mmHg)	82 ± 7	84 ± 9	**0.03**

1 Mean ± SD (all such values)

2 P-value is significant ≤ 0.05. Statistical analysis made using two tailed t-test.

A higher proportion of female participants ate more often than three times per day, as compared to men (93% vs 78%, p= 0.01). Females on average tended to eat more snacks per day than men with 79% of female participants eating >1 snack per day and 61% of men eating >1 snack per day (p = 0.03) (Table 7).

Table 7. Eating pattern in relation to sex (n=176).

Variariables	Male[1]	Female	P-value[2]
Sex, n	36 (21)	140 (79)	
Number of eating occasions/d			**0.01**
≤3	8 (22)	10 (7)	
>3	28 (78)	129 (93)	
Number of snacks/d			**0.03**
0-1	14 (39)	29 (21)	
>1	22 (61)	110 (79)	
Number of meals with cooked food/d			0.50
1	12 (33)	52 (37)	
2	24 (67)	86 (62)	
Largest meal consumed/d			0.73
Lunch	10 (28)	39 (28)	
Dinner	5 (14)	24 (17)	
Two large meals	21 (58)	75 (54)	
Self-reported eating habits			0.80
Good	20 (59)	82 (61)	
Bad	14 (41)	52 (39)	

1 All values are n (%) unless otherwise indicated

2 P-value is significant ≤ 0.05. Statistical analysis made using Chi-square test.

A difference in eating patterns according to age was seen on all patterns except total number of eating occasions per day where no difference was detected (Table 8). A higher proportion in the older age group consumed more than one snack per day (82% vs 68%, p <0.00) and fewer ate two cooked meals per day (51% vs 75%, p <0.00). Participants <55 years of age were more likely to consume two cooked meals per day and less likely to snack than the older

age group. Participants ≥55 years of age rated their eating habits as "Good" to a greater extent (64%) than the younger age group (52%) (p=0.02).

Table 8. Eating pattern in relation to age (n=176)

Variariables	< 55[1]	≥ 55	P-value[2]
Age, n	81 (46)	95 (54)	
Number of eating occasions/d			0.18
≤3	11 (14)	7 (7)	
>3	70 (86)	87 (93)	
Number of snacks/d			0.03
0-1	26 (32)	17 (18)	
>1	55 (68)	77 (82)	
Number of meals with cooked food/d			0.00
1	19 (24)	46 (49)	
2	61 (75)	48 (51)	
Largest meal consumed/d			0.00
Lunch	15 (19)	35 (37)	
Dinner	9 (11)	19 (20)	
Two large meals	56 (70)	40 (43)	
Self-reported eating habits			0.02
Good	42 (52)	60 (64)	
Bad	39 (48)	27 (29)	

1 All values are n (%) unless otherwise indicated

2 P-value is significant ≤ 0.05. Statistical analysis made using Chi-square test.

No relations between self-rated eating habits and actual eating patterns was found (Table 9).

Table 9. Eating pattern in relation to self-rated eating habits (n=169).

Variables	Good	Bad	P-Value
Number of eating occasions/d			0.85
≤ 3	10 (10)	7 (10)	
> 3	93 (90)	59 (90)	
Number of snacks/d			0.38
0-1	28 (27)	14 (21)	
>1	75 (73)	52 (79)	
Number of meals with cooked food			0.2
1	33 (32)	27 (41)	
2	70 (68)	38 (58)	

1 All values are n (%) unless otherwise indicated

2 P-value is significant ≤ 0.05. Statistical analysis made using Chi-square test.

Discussion

Principal findings

This study investigated the eating patterns of a rather homogenous group of overweight Swedish adults, the vast majority being middle-aged women. The most common eating pattern was consuming food five times per day including breakfast, two main meals (lunch and dinner) and two snacks with some differences in relation to sex and age. There was no relation between number of eating occasions and body measurements or blood pressure. A lower systolic blood pressure was found among the participants consuming two main meals as compared to one main meal and a lower diastolic blood pressure was found among participants rating their eating habits as "Good" rather than "Bad".

Findings in relation to other research

Our findings of a difference in eating patterns between men and women are in line with similar results previously reported. In a study from 2018 on eating patterns of US adults, women reported eating three main meals plus at least one snack to a greater degree than men (16). Both the number of snacks per day and the number of meals per day were higher among women than in men. Also, to be noted is that the American adults reported eating a total of five times per day in general, including two snack episodes daily. This eating pattern as was similar to what was found in our study.

No clear relation between BMI and the different eating patterns was seen in our study. Older studies have pointed towards an increased eating frequency being a good strategy for weight loss and weight control (5, 7) while more recent studies has shown the opposite (4, 6). Consuming food less frequently could lead to weight loss by consuming less unhealthy snacks and therefore consuming less calories. In contrast, an increased eating frequency has been linked to a higher diet quality in studies (17, 18) which could be the reason why an increased eating frequency could be a good strategy for weight loss. This indicates that not only eating frequency but overall diet quality is of great importance in weight management. As the participants in our study were considered to be a rather homogenous group with similar eating patterns, difficulties arose in finding associations between BMI and eating patterns. A control group with a normal BMI would have given the option to compare eating patterns between the groups. Knowing the eating patterns of a healthy group of people with BMI <27 would have given us the options to draw conclusions whether the way of eating differs according to body weight and other body measurements It is apparent that more studies on eating patterns

and their relation to weight control, health and general body measurements are needed. Further studies could facilitate food advice focusing on meal order and eating patterns rather than food content, as the variations in food content are great and comes with difficulties when giving detailed advice.

Older participants ate less cooked meals and snacked more than younger participants. This could indicate a decline in food intake as snacks on a general level are less nutritious than cooked meals. Several studies have demonstrated a decline in food intake with increasing age (19, 20). The mean age of the participants in these studies was 72 years (19) and 52 years (20), while the mean age of the participants in our older age group was 62 years, hence, the results might be applicable on our group. The reasons for this a decline in food intake is not completely understood, however there are many different factors that could play a role. In 2018 a study exploring dietary habits and food choices of older adults in The United Kingdom was published (21). Four themes of age related changes was identified as possible reasons for the decline in food intake with age: being on your own (living alone and cooking for one), access to food (food costs and support), changes related to age (less physical activity, a decline in hunger) and emotions connected to food (eating a varied diet, dieting). Being on your own could lead to a diminished effort to cook as you have no one to share the food with and no one to cook for. Many participants in the study reported cooking simpler meals and eating less frequently later in life. This could be an explanation to why the eating patterns in our older group significantly differed from the younger group. However, as the majority of participants in the study from 2018 having been >70 years old it is not sure that the same reasons could be applicable on the older age group in our study (21).

Obesity is an established risk factor for hypertension. There are few studies reporting on the associations between eating patterns and blood pressure. We found that participants eating two cooked meals per day rather than one cooked meal per day had a lower systolic blood pressure. To note is that this association is not fully understood and is not considered convincing as there was a low number of participants and no association between diastolic blood pressure and number of cooked meals was found. This could be due to errors in data collection. As of now we have not been able to find any similar studies linking blood pressure to number of meals with cooked food. Two studies found a link between a higher eating frequency and lower systolic and diastolic blood pressure (22, 23). Other studies has found no associations between eating frequency and the prevalence of hypertension (12, 24). In one

study conducted in 2019 the timing of main meals in relation to blood pressure was examined (12). The results were that a "later" lunch (after 1 p.m) compared to a "conventional" lunch (12-1 p.m) was associated with a higher blood pressure in Australian woman. The reason for the association between meal frequency and the timing of meals and blood pressure is not known. However, there are recent studies indicating that meal frequency is a possible determinant of diet quality and nutrient intake and that a higher meal frequency is associated with a better diet quality (17, 18). This suggests that overall diet quality and nutrient intake could play a role in preventing hypertension, rather than the actual eating patterns themselves playing a role.

Strengths and weaknesses

Strengths of our study is the high participation rate and the low internal non-response. The only missing data (n=7) was for the item self-rated eating habits. Anthropometrics were taken in a standardized way by experienced nurses and the questionnaires were answered on location during the health examination. This allowed for the participants being able to ask questions if something was unclear and made sure that measurements were taken correctly. The data collection done this way is considered as a strength.

As the study was conducted on a rather homogenous group of overweight Swedish adults it is difficult to generalize conclusions to the general population. However, the fact that the study group was homogenous can also be considered as a strength as the results can be specifically applicable on for example middle-aged overweight women wanting to lose weight.

The major limitations are the cross-sectional design and the lack of data on food content. Food content is likely to co-vary between number of eating occasions. We did not have the possibility to adjust for potential confounding by dietary factors such as macronutrient composition of food intake. The cross-sectional study design does not allow for assessing causal relations between eating patterns and how they influence body measurements such as BMI, waist measurements and blood pressure. A way to improve the study would have been to compare eating patterns and body measurements at baseline with mentioned variables in a later follow up. This would give the ability to see whether the eating habits changed during the year after being included in the study. It also would have shown whether BMI changed and given the opportunity to draw conclusions about how a change in eating patterns affects body measurements. Diet, food content, eating patterns, meal habits and body measurements

such as BMI are tightly interconnected to one another which makes it such difficult topic to study. There is evidence that it is common to state healthier eating habits than one actually has, which can make the result misleading if the information stated is not correct (25).

As the participants got to fill in what they eat in a typical day by hand a possible weakness was seen in difficulties interpreting the answers given. Two different people trying to interpret the answers written would most likely not perceive the answers in an equal way, which is a potential source of error. The data material was difficult to interpret as all participants filled in their eating habits with varying accuracy and detail. An estimation would be that 15-20% of the data material was difficult to code into decided variables. An improvement could be to time the intervals of the eating windows in which the participants filled in what they ate in an typical day. This would have made the interpretation of the answers given less difficult.

Participation in the study was entirely voluntary and with the application of described exclusion criteria there was no medical risk linked with participation. On the contrary one could state that the participants have gained an insight in what their eating patterns look like as well as knowledge about current body measurements and what impact they might have on health. For many of the participants being included it could be seen as a beginning of wanting to change their behavior contributing to unhealthy habits and improve their nutritional status.

Conclusions

In conclusion, our results suggest that the most common eating pattern among overweight Swedish adults consisted of consuming breakfast, snacking two times per day (morning and afternoon) and eating lunch and dinner consisting of cooked meals. Women snacked more and ate more times per day than men did. Participants ≥55 years of age ate more snacks and less cooked food than participants <55 years of age. There was an association between blood pressure and number of cooked meals as well as self-rated eating habits. Further research on how eating patterns affects health and body measurements such as BMI and blood pressure is warranted as it might give future insights valuable for health counselling.

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