

**This is an electronic reprint of the original article.
This reprint *may differ* from the original in pagination and typographic detail.**

Author(s): Järvelä-Reijonen, Elina; Karhunen, Leila; Sairanen, Essi; Rantala, Sanni; Laitinen, Jaana; Puttonen, Sampsa; Peuhkuri, Katri; Hallikainen, Maarit; Juvonen, Kristiina; Myllymäki, Tero; Föhr, Tiina; Pihlajamäki, Jussi; Korpela, Riitta; Ermes, Miikka; Lappalainen, Raimo; Kolehmainen, Marjukka

Title: High perceived stress is associated with unfavorable eating behavior in overweight and obese Finns of working age

Year: 2016

Version:

Please cite the original version:

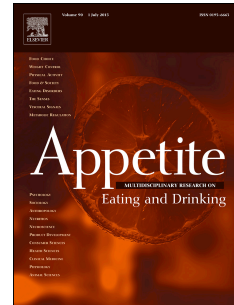
Järvelä-Reijonen, E., Karhunen, L., Sairanen, E., Rantala, S., Laitinen, J., Puttonen, S., Peuhkuri, K., Hallikainen, M., Juvonen, K., Myllymäki, T., Föhr, T., Pihlajamäki, J., Korpela, R., Ermes, M., Lappalainen, R., & Kolehmainen, M. (2016). High perceived stress is associated with unfavorable eating behavior in overweight and obese Finns of working age. *Appetite*, 103(August), 249-258.
<https://doi.org/10.1016/j.appet.2016.04.023>

All material supplied via JYX is protected by copyright and other intellectual property rights, and duplication or sale of all or part of any of the repository collections is not permitted, except that material may be duplicated by you for your research use or educational purposes in electronic or print form. You must obtain permission for any other use. Electronic or print copies may not be offered, whether for sale or otherwise to anyone who is not an authorised user.

Accepted Manuscript

High perceived stress is associated with unfavorable eating behavior in overweight and obese Finns of working age

Elina Järvelä-Reijonen, Leila Karhunen, Essi Sairanen, Sanni Rantala, Jaana Laitinen, Sampsa Puttonen, Katri Peuhkuri, Maarit Hallikainen, Kristiina Juvonen, Tero Myllymäki, Tiina Föhr, Jussi Pihlajamäki, Riitta Korpela, Miikka Ermes, Raimo Lappalainen, Marjukka Kolehmainen



PII: S0195-6663(16)30144-1

DOI: [10.1016/j.appet.2016.04.023](https://doi.org/10.1016/j.appet.2016.04.023)

Reference: APPET 2960

To appear in: *Appetite*

Received Date: 23 December 2015

Revised Date: 2 April 2016

Accepted Date: 19 April 2016

Please cite this article as: Järvelä-Reijonen E., Karhunen L., Sairanen E., Rantala S., Laitinen J., Puttonen S., Peuhkuri K., Hallikainen M., Juvonen K., Myllymäki T., Föhr T., Pihlajamäki J., Korpela R., Ermes M., Lappalainen R. & Kolehmainen M., High perceived stress is associated with unfavorable eating behavior in overweight and obese Finns of working age, *Appetite* (2016), doi: 10.1016/j.appet.2016.04.023.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

1 **High perceived stress is associated with unfavorable eating behavior in overweight and obese Finns**
2 **of working age**

3

4 Elina Järvelä-Reijonen^{a*} Email: elina.jarvela-reijonen@uef.fi

5 Leila Karhunen^{a,b} Email: leila.karhunen@uef.fi

6 Essi Sairanen^c Email: essi.sairanen@jyu.fi

7 Sanni Rantala^d Email: sanni.rantala@helsinki.fi

8 Jaana Laitinen^e Email: jaana.laitinen@ttl.fi

9 Sampsa Puttonen^e Email: sampsa.puttonen@ttl.fi

10 Katri Peuhkuri^d Email: katri.peuhkuri@netnut.fi

11 Maarit Hallikainen^a Email: maarit.hallikainen@uef.fi

12 Kristiina Juvonen^a Email: kristiina.juvonen@uef.fi

13 Tero Myllymäki^c Email: tero.myllymaki@firstbeat.fi

14 Tiina Föhr^f Email: tiina.fohr@jyu.fi

15 Jussi Pihlajamäki^{a,b} Email: jussi.pihlajamaki@uef.fi

16 Riitta Korpela^d Email: riitta.korpela@helsinki.fi

17 Miikka Ermes^g Email: miikka.ermes@vtt.fi

18 Raimo Lappalainen^c Email: raimo.lappalainen@jyu.fi

19 Marjukka Kolehmainen^{a,b} Email: marjukka.kolehmainen@uef.fi

20

21 ^a Institute of Public Health and Clinical Nutrition, Clinical Nutrition, University of Eastern Finland, P.O. Box
22 1627, FI-70211 Kuopio, Finland;

23 ^b Institute of Clinical Medicine and Clinical Nutrition, Kuopio University Hospital, P.O. Box 100, FI-70029
24 KYS, Finland;

25 ^c Department of Psychology, University of Jyväskylä, P.O. Box 35, FI-40014 University of Jyväskylä, Finland;

26 ^d Medical Faculty, Pharmacology, Medical Nutrition Physiology, University of Helsinki, P.O. Box 63, FI-00014
27 University of Helsinki, Helsinki, Finland;

28 ^e Finnish Institute of Occupational Health, P.O. Box 40, FI-00251 Helsinki, Finland;

29 ^f Department of Health Sciences, University of Jyväskylä, P.O. Box 35, FI-40014 Jyväskylä, Finland;

30 ^g VTT Technical Research Centre of Finland, P.O. Box 1300, FI-33101 Tampere, Finland

31 *Corresponding author. Institute of Public Health and Clinical Nutrition, Clinical Nutrition, University of
32 Eastern Finland, P.O. Box 1627, FI-70211 Kuopio, Finland. E-mail address: elina.jarvela-reijonen@uef.fi

33

34 **ABSTRACT**

35 Stress-related eating may be a potential factor in the obesity epidemic. Rather little is known about how
36 stress associates with eating behavior and food intake in overweight individuals in a free-living situation.
37 Thus, the present study aims to investigate this question in psychologically distressed overweight and obese
38 working-aged Finns.

39 The study is a cross-sectional baseline analysis of a randomized controlled trial. Of the 339 study
40 participants, those with all the needed data available ($n=297$, 84% females) were included. The mean age
41 was 48.9 y ($SD=7.6$) and mean body mass index 31.3 kg/m^2 ($SD=3.0$). Perceived stress and eating behavior
42 were assessed by self-reported questionnaires Perceived Stress Scale (PSS), Intuitive Eating Scale, the
43 Three-Factor Eating Questionnaire, Health and Taste Attitude Scales and ecSatter Inventory. Diet and
44 alcohol consumption were assessed by 48-h dietary recall, Index of Diet Quality, and AUDIT-C.

45 Individuals reporting most perceived stress (i.e. in the highest PSS tertile) had less intuitive eating, more
46 uncontrolled eating, and more emotional eating compared to those reporting less perceived stress ($p<0.05$).
47 Moreover, individuals in the highest PSS tertile reported less cognitive restraint and less eating competence
48 than those in the lowest tertile ($p<0.05$). Intake of whole grain products was the lowest among those in the

49 highest PSS tertile ($p < 0.05$). Otherwise the quality of diet and alcohol consumption did not differ among the
50 PSS tertiles.

51 In conclusion, high perceived stress was associated with the features of eating behavior that could in turn
52 contribute to difficulties in weight management. Stress-related way of eating could thus form a potential risk
53 factor for obesity. More research is needed to develop efficient methods for clinicians to assist in handling
54 stress-related eating in the treatment of obese people.

55

56 **Keywords**

57 Perceived stress, Eating behavior, Intuitive eating, Emotional eating, Dietary intake, Obesity

58

59 **INTRODUCTION**

60 Several definitions of stress include the idea in which “environmental demands tax or exceed the adaptive
61 capacity of an organism, resulting in psychological and biological changes that may place persons at risk for
62 disease” (Cohen, Kessler, & Gordon, 1997). Adaptation or coping response to stress changes behavior
63 which is one of the mechanisms how stress can increase the risk (Cohen, Janicki-Deverts, & Miller, 2007)
64 for, for example, weight gain (Wardle, Chida, Gibson, Whitaker, & Steptoe, 2011), metabolic syndrome
65 (Raikkonen, Matthews, & Kuller, 2007), and cardiovascular disease (Cohen et al., 2007). In addition, eating
66 as a way of trying to cope with stress has been related to failure to maintain weight loss among formerly
67 obese (Byrne, 2002). Rather little is known about the relationship between stress and the behavioral traits of
68 eating. There is a need for research between eating behavior and naturally occurring stress instead of
69 laboratory-measured, artificially-induced, acute stress which may not resemble the situations people
70 encounter in their daily life (Stewart-Knox, 2014; Torres & Nowson, 2007).

71 In previous studies in real-life context, chronic stress has been associated with higher uncontrolled eating
72 (Groesz et al., 2012; Nevanpera et al., 2012) and emotional eating (Nevanpera et al., 2012) in women.
73 These features of eating behavior, uncontrolled and emotional eating, are related to unhealthy dietary
74 patterns and negative health-related outcomes such as higher body mass index (BMI) (de Lauzon et al.,
75 2004; Kontinen, Mannisto, Sarlio-Lahteenkorva, Silventoinen, & Haukkala, 2010; Nevanpera et al., 2012).

76 Stress seems to have a negative impact also on food choices. Chronic stress has been associated with
77 increased consumption of highly palatable foods in women (Groesz et al., 2012) and in both genders (Oliver
78 & Wardle, 1999). Higher perceived stress has also been associated with increased consumption of high-fat
79 snacks and fast-food items in both genders (Barrington, Beresford, McGregor, & White, 2014). Similarly,
80 stress-driven eating, meaning eating or drinking to feel better in stressful situations, has been related to more
81 frequent consumption of sausages, hamburgers, pizza, chocolate and alcoholic beverages in both men and
82 women and adolescents (Jaaskelainen et al., 2014; Laitinen, Ek, & Sovio, 2002). However, stress has not
83 been consistently associated with the quality of diet (Barrington et al., 2014; Ferranti et al., 2013;
84 Grossniklaus et al., 2010; Suominen-Taipale et al., 2010).

85 To the best of our knowledge, the association between stress and positive features of eating behavior such
86 as intuitive eating (Tylka, 2006) and eating competence (Satter, 2007) has not been studied earlier. This
87 association might be interesting since it has been observed that intuitive eating, e.g. eating based on hunger
88 and satiety and not emotions, has been associated with lower BMI (Herbert, Blechert, Hautzinger, Matthias,
89 & Herbert, 2013; Tylka, 2006), better psychological well-being (Tylka, 2006), and possibly better dietary
90 intake and/or eating behavior (Van Dyke & Drinkwater, 2014). Eating competence, e.g. having positive
91 attitudes about eating and consuming the amount of food that satiates hunger and appetite, has also been
92 associated with lower BMI (Krall & Lohse, 2011; Lohse, Satter, Horacek, Gebreselassie, & Oakland, 2007),
93 in addition to higher HDL-cholesterol and lower systolic blood pressure (Psota, Lohse, & West, 2007), and
94 better diet quality (Lohse, Bailey, Krall, Wall, & Mitchell, 2012).

95 Improved understanding on eating behavior, food consumption and nutrient intake associated with perceived
96 stress might help to develop methods and contents of dietary counseling and thus improve their
97 effectiveness among overweight and obese individuals. However, to the best of our knowledge, the
98 associations of eating behavior and diet quality with perceived stress have not been studied earlier in
99 psychologically distressed overweight and obese adults in a naturalistic setting outside laboratory. Therefore,
100 the aim of the present study was to investigate, in a real-life context, features of eating behavior, both
101 unfavorable and favorable, food consumption, and energy nutrient intake in psychologically distressed
102 overweight and obese Finns reporting different levels of perceived stress. We hypothesized that higher level
103 of perceived stress associates with unfavorable eating behavior and poorer diet quality.

104

105 **METHODS**

106 Study design and participants

107 The present paper is a cross-sectional retrospective analysis of the baseline measurements of the Elixir
108 clinical intervention trial (Lappalainen et al., 2014). The aim of the Elixir study was to investigate the effect of
109 three different psychological intervention methods on psychological and physiological well-being and on the
110 features of metabolic syndrome. The study was approved by the ethics committee of the Central Finland
111 Health Care District (reference number 7U/2012) and it was performed in accordance with the Declaration of
112 Helsinki. The participants gave their written informed consent before participating. The study is registered
113 with ClinicalTrials.gov with the identifier NCT01738256.

114 The study protocol is described by Lappalainen et al. (Lappalainen et al., 2014). Briefly, the study
115 participants were recruited by advertisements in local newspapers. As the criterion, the participants had to
116 be 25 – 60 years old and have a BMI 27 – 34.9 kg/m². They also had to be psychologically distressed (≥ 3
117 points from the General Health Questionnaire, GHQ-12 (Goldberg, 1972) and have computer and internet
118 access. There were also several exclusion criteria, such as diagnosed severe chronic illness and eating
119 disorder (bulimia nervosa) evaluated at the screening and asked in the baseline questionnaire. The
120 multicenter study was conducted in three cities in Finland (Jyväskylä, Kuopio and Helsinki). The study was
121 carried out in two phases in order to diminish the effect of seasonal variation and because of the limited
122 capacity to conduct measurements per day. The baseline measurements were taken in September and
123 October 2012, and in January and February 2013. The participants filled in electronic questionnaires, visited
124 the local study center for clinical and biochemical measurements, and reported their food consumption in a
125 48-hour dietary recall by telephone.

126 After randomization (n=339), 41 (12%) participants dropped out or were excluded (not fitting inclusion and
127 exclusion criteria, n = 19 (6%); medical condition, n = 2 (1%); not attending to the baseline measurements, n
128 = 20 (6%)). In addition, one participant did not complete all the questionnaires. Therefore, 297 participants
129 (249 females, 48 males) were included for the analysis of the present study. The descriptive characteristics
130 of the participants are shown in Table 1. Majority (79%) had at least college education. Most of the
131 participants (84%) did not smoke. Almost three-fourths (74%) were married or cohabiting, and 41% had one
132 or more underage children. Majority (89%) was aiming to lose weight.

133

134 Table 1. Descriptive characteristics of the participants (n=297).

Characteristic	Mean \pm SD	Range
Age (y)	48.9 \pm 7.6	26.6 – 60.8
Weight (kg)	87.9 \pm 11.0	64.0 – 120.1
Height (cm)	167.5 \pm 8.0	149.0 – 195.6
BMI (kg/m ²)	31.3 \pm 3.0	25.3 – 40.1
Waist circumference (cm)	102.9 \pm 8.7	79.7 – 124.0
Psychological distress (GHQ-12 score) ^a	7.1 \pm 2.8	3.0 – 12.0

135 Notes: BMI = body mass index; GHQ-12 = General Health Questionnaire-12.

136 ^a Bimodal scale.

137

138 Measurements

139 Clinical measurements

140 Weight, height and waist circumference were measured at each study center in the morning after a 12-h
 141 overnight fast with calibrated instruments (Lappalainen et al., 2014). BMI was calculated from the measured
 142 weight and height as kilograms per meters squared.

143 Background characteristics

144 Demographic information, such as age, marital status, number of underage children in household, education,
 145 smoking, regular medication, and type of working hours (daytime job, two-shift work, or irregular work), was
 146 collected by a questionnaire. Symptoms of depression were measured by the Beck Depression Inventory-II
 147 (Beck, Steer, Ball, & Ranieri, 1996). Depressive symptoms were categorized into no/minimal depression (0 –
 148 13 points), mild depression (14 – 19 points), moderate depression (20 – 28 points), and severe depression
 149 (29 – 63 points).

150 Psychological distress and perceived stress

151 The 12-item General Health Questionnaire, GHQ-12 (Goldberg, 1972), was used for screening the
152 volunteers for psychological distress. It has been found to be a valid screening tool for common mental
153 health problems also in the Finnish population (Holi, Marttunen, & Aalberg, 2003). Respondent was asked,
154 considering the past few weeks, to answer questions such as “Have you recently felt capable of making
155 decisions about things?”. In the screening, bimodal GHQ scoring was used: “not at all” (0 points); “same as
156 usual” (0); “rather more than usual” (1); and “much more than usual” (1), with the total sum score ranging
157 from 0 to 12. Cronbach’s alpha using bimodal scoring was 0.72. In the present analyses, Likert scoring
158 system (0,1,2,3 points; possible range 0 – 36) was used for statistical analyses to achieve larger variation of
159 the GHQ-12 scores. Cronbach’s alpha using Likert scoring was 0.80.

160 Perceived Stress Scale, PSS (Cohen, Kamarck, & Mermelstein, 1983), is a 14-item measure for assessing
161 the degree to which a person perceives life as stressful. The questionnaire has proved acceptable
162 psychometric properties worldwide (Lee, 2012). Questions concern how often a person has experienced
163 certain feelings and thoughts during the previous month, for example “In the last month, how often have you
164 found that you could not cope with all the things that you had to do?”. The 5-point Likert scale from “never”
165 (0) to “very often” (4) is summed for the total score (possible range 0 – 56). Half of the items are positive, for
166 example “In the last month, how often have you felt that things were going your way?”. Those items are
167 scored in the reverse direction. Cronbach’s alpha was 0.88 in this sample.

168 Eating behavior

169 Intuitive Eating Scale, IES (Tylka, 2006), consists of 21 items with subcategories of the intuitive eating: (a)
170 Unconditional Permission to Eat (9 items, for example “If I am craving a certain food, I allow myself to have
171 it.”), (b) Eating for Physical Rather Than Emotional Reasons (6 items, for example “I stop eating when I feel
172 full (not overstuffed).”), and (c) Reliance on Internal Hunger/Satiety Cues (6 items, for example “I trust my
173 body to tell me when to eat.”). The statements are answered with a 5-point Likert scale ranging from
174 “strongly disagree” (1) to “strongly agree” (5). The scores are averaged, thus possible ranges of IES total
175 score and its subscales are 1 – 5. Cronbach’s alpha was 0.80 for the whole scale and 0.69; 0.86; 0.76 for the
176 subscales Unconditional Permission to Eat, Eating for Physical Rather Than Emotional Reasons, and
177 Reliance on Internal Hunger/Satiety Cues, respectively.

178 The Three-Factor Eating Questionnaire, TFEQ-R18 (Karlsson, Persson, Sjostrom, & Sullivan, 2000), was
179 used to measure (a) Cognitive Restraint (6 items, for example “I deliberately take small helpings as a means

180 of controlling my weight.”), (b) Uncontrolled Eating (9 items, for example “Sometimes when I start eating, I
181 just can’t seem to stop.”), and (c) Emotional Eating (3 items, for example “When I feel blue, I often overeat.”).
182 Answers are given by 4-point Likert scale except for one item which is answered by 8-point Likert scale. The
183 possible range of the total scores is 0 – 100. Cronbach’s alphas were 0.70; 0.88; 0.88 for the subscales
184 Cognitive Restraint, Uncontrolled Eating, and Emotional Eating, respectively.

185 Of the Finnish Health and Taste Attitude Scales, HTAS (Roininen, Lahteenmaki, & Tuorila, 1999),
186 subcategories (a) Pleasure (6 items, for example “When I eat, I concentrate on enjoying the taste of food.”)
187 and (b) Using Food as a Reward (6 items, for example “I reward myself by buying something really tasty.”)
188 were used. The statements were answered with a 7-point Likert scale ranging from “strongly disagree” (1) to
189 “strongly agree” (7). The scores are averaged, thus the possible ranges of the scores are 1 – 7. Cronbach’s
190 alphas were 0.71 and 0.79 for the subcategories Pleasure and Using Food as a Reward, respectively.

191 Eating competence was measured by preliminary Finnish translation of ecSatter Inventory for Low-Income,
192 ecSI/LI (Krall & Lohse, 2010; Krall & Lohse, 2011) which was recently named as ecSI 2.0 (Lohse, 2015). The
193 definition of eating competence consists of four components which also constitutes the 16-item
194 questionnaire’s subcategories: (a) Eating Attitudes (5 items, for example “I am relaxed about eating.”), (b)
195 Food Acceptance (3 items, for example “I experiment with new food and learn to like it.”), (c) Internal
196 Regulation (3 items, for example “I eat as much as I am hungry for.”), and (d) Contextual Skills (5 items, for
197 example “I generally plan for feeding myself. I don’t just grab food when I get hungry.”). The statements are
198 answered: “always” (3 points); “often” (2); “sometimes” (1); “rarely” (0); or “never” (0). The possible range of
199 Eating Competence total sum score is 0 – 48; Eating Attitudes and Contextual Skills 0 – 15; and Food
200 Acceptance and Internal Regulation 0 – 9. Total sum score ≥ 32 indicates a competent eater (Lohse et al.,
201 2007) meaning that the person has positive attitudes about eating and about food, accepts and eats an ever-
202 increasing variety of foods, eats intuitively enough according to internal hunger and satiety signals, and has
203 skills and resources for managing daily meals (Satter, 2007). Cronbach’s alpha was 0.76 for the whole scale
204 and 0.62; 0.66; 0.58; 0.74 for the subscales Eating Attitudes, Food Acceptance, Internal Regulation, and
205 Contextual Skills, respectively.

206 Food consumption and nutrient intake

207 A concise measure of food consumption, Index of Diet Quality (IDQ) (Leppala, Lagstrom, Kaljonen, &
208 Laitinen, 2010), consists of 18 questions about frequency, portion size and type of certain foods and drinks

209 consumed during the previous month to evaluate adherence to nutrition recommendations. It has been
210 developed and validated in Finnish healthy, mostly normal weight, adult females by using the seven-day food
211 record (Leppala et al., 2010). The possible IDQ total score is 0 – 15. Points below 10 indicate non-adherence
212 and points from 10 to 15 indicate adherence to the health-promoting diet (Leppala et al., 2010). In this study,
213 answers that seemed possibly unrealistic or outliers were checked from the participant and corrections were
214 made when needed. Despite this procedure, one answer (10 glasses = 20 dl juice per day) remained
215 unverified and was coded as missing.

216 Alcohol consumption during the previous six months was measured by the Finnish version of the
217 questionnaire Alcohol Use Disorders Identification Test Consumption, AUDIT-C (Bush, Kivlahan, McDonell,
218 Fihn, & Bradley, 1998). It has been shown to have strong correlation to alcohol consumption in a general
219 Finnish population (Aalto, Alho, Halme, & Seppa, 2009). The questionnaire contains three questions about
220 the frequency and amounts of alcohol usage. For the questions concerning the amount of drinks consumed,
221 a list of typical Finnish serving sizes and their corresponding amounts as standard drinks (e.g. 33 cl bottle of
222 beer is one drink) were provided. The responses were scored from 0 to 4 and summed, and the possible
223 total score is from 0 to 12. Cronbach's alpha was 0.69.

224 The 48-h dietary recall was conducted to collect information of nutrient intake. Participants were asked to
225 describe all foods and drinks eaten and drunk during the previous full 48 hours (from 00.00 to 24.00). The
226 interview was conducted by trained nutritionists on the telephone at pre-scheduled time. Participants were
227 told that the interview considers diet but anything about 48-h recall was not mentioned beforehand. An
228 electronic picture book (Paturi, Nieminen, Reinivuo, & Ovaskainen, 2006) was used to help to describe
229 portion sizes. The interviews were performed from Tuesday to Friday, so Fridays and Saturdays are
230 excluded from the data. The collected data was coded and nutrient intake calculated with AivoDiet software
231 version 2.0.2.2 (Aivo Ltd., Turku, Finland) using the Fineli® Finnish Food Composition Database (National
232 Institute for Health and Welfare, Nutrition Unit, Helsinki, Finland). The interview protocol of the 48-h dietary
233 recall was created based on the face-to-face 48-h dietary recall conducted in the national FINDIET 2012
234 survey (Helldán et al., 2013). The 48-h dietary recall protocol of the Elixir study was done together by the
235 three nutritionists who also conducted the interviews. The participants were encouraged to be truthful in the
236 48-hour dietary recall and they were told that the interviewer will not assess or comment on their eating and
237 drinking or give any dietary guidance. The foods and beverages consumed during the 48 hours were

238 repeated at the end and the interviewer encouraged the participant to make additions or modifications while
239 repeating the course of days' events.

240 Data collected by the 48-h dietary recall was also utilized to calculate average daily intake of food items in
241 specific categories: Vegetables (excluding potatoes); Fruits and berries; Rye bread; Whole grain products;
242 Fish; Pastries (sweet and savory); and Salty snacks and sweets. Food consumption was calculated as
243 grams and energy-adjusted grams per 1 MJ.

244 Statistical methods

245 Data were analyzed using IBM SPSS Statistics version 21. The study participants were divided into tertiles
246 based on their PSS sum scores; the lowest ($n=104$, $\text{mean}=18.3$, $\text{SD}=4.2$, $\text{range}=7 - 23$), middle ($n=102$,
247 $\text{mean}=27.0$, $\text{SD}=1.9$, $\text{range}=24 - 30$), and the highest ($n=91$, $\text{mean}=35.4$, $\text{SD}=3.8$, $\text{range}=31 - 52$) tertile
248 because there are no cut-off scores for the scale (Cohen, 2015). The normality assumption was assessed by
249 the histograms of the standardized residuals. Intake of sucrose (E%) was log-transformed to achieve normal
250 distribution of the standardized residuals. All the food consumption variables (g and g/MJ) were non-normally
251 distributed.

252 To test the differences of normally distributed continuous variables in PSS tertiles, one-way ANOVA with
253 Tukey HSD post hoc comparisons was used. Multiway ANOVAs were conducted by adjusting for study
254 center, starting time of the study, aim to lose weight, and gender. Non-normally distributed variables were
255 analyzed in PSS tertiles by Kruskal-Wallis test. Categorical variables in PSS tertiles were assessed by
256 Pearson chi-square test or Fisher's exact test.

257 Pearson correlation was used to assess the relation of continuous normally distributed variables and
258 Spearman correlation for non-normally distributed variables. P-values <0.05 were considered as statistically
259 significant.

260

261 RESULTS

262 Psychological distress and perceived stress

263 In the whole study population the mean GHQ-12 Likert score was 19.5 ± 4.3 (mean \pm SD) and the scores
264 ranged from 10 to 34. PSS was positively correlated to GHQ-12 Likert score ($r = 0.461$, $p < 0.001$). Although

265 psychologically distressed participants were recruited, there was a large variation in perceived stress among
266 the participants: PSS scores ranged from 7 to 52 with the mean 26.5 ± 7.7 .

267 The participants were evenly distributed in the PSS tertiles in terms of their descriptive characteristics. There
268 were no statistically significant differences among PSS tertiles in starting time of the study, study center,
269 gender, age, BMI, waist circumference, marital status, number of underage children in household, education
270 level, smoking, having regular medication, and type of working hours (Table 2). Aiming to lose weight was
271 more common in the lowest and middle PSS tertiles than in the highest tertile ($\chi^2(2) = 6.837, p=0.033$) and
272 depressive symptoms were more common and severe in the highest tertile than in the lowest or middle
273 tertiles ($p<0.001$).

274

275 Association of eating behavior with perceived stress

276 Higher perceived stress was associated with several features of eating behavior: lower intuitive eating ($F[2,$
277 $294]=5.49, p=0.005$), less eating for physical rather than emotional reasons ($F[2, 294]=8.52, p<0.001$), lower
278 reliance on internal hunger/satiety cues ($F[2, 294]=3.84, p=0.023$), less cognitive restraint ($F[2, 294]=3.72,$
279 $p=0.025$), lower eating competence ($F[2, 294]=4.63, p=0.011$), and lower contextual skills ($F[2, 294]=5.77,$
280 $p=0.003$) (Figure 1). In addition, higher perceived stress was associated with uncontrolled eating ($F[2,$
281 $294]=9.18, p<0.001$), emotional eating ($F[2, 294]=11.69, p<0.001$), seeking pleasure from food ($F[2,$
282 $294]=3.08, p=0.047$), and using food as a reward ($F[2, 294]=4.73, p=0.010$). Post hoc analyses indicated that
283 compared to the middle and lowest PSS tertiles, persons in the highest tertile (i.e. reporting most perceived
284 stress) had less intuitive eating (mean \pm SD 30.0 ± 0.5 vs. 30.0 ± 0.5 vs. 2.8 ± 0.5 , Tukey HSD post hoc test,
285 $p=0.007, p=0.019$, respectively). Furthermore, eating competence was significantly lower in the highest
286 compared to the lowest perceived stress tertile (mean \pm SD 24.7 ± 5.7 vs. 27.3 ± 6.1 , Tukey HSD post hoc test,
287 $p=0.007$). Other post hoc test results are shown in Figure 1. The associations remained statistically
288 significant after adjusting for gender.

289

290 Fig. 1 as a 1.5 or 2-column fitting image

291

292 Table 2. Descriptive characteristics of the participants (n=297) in the perceived stress tertiles.

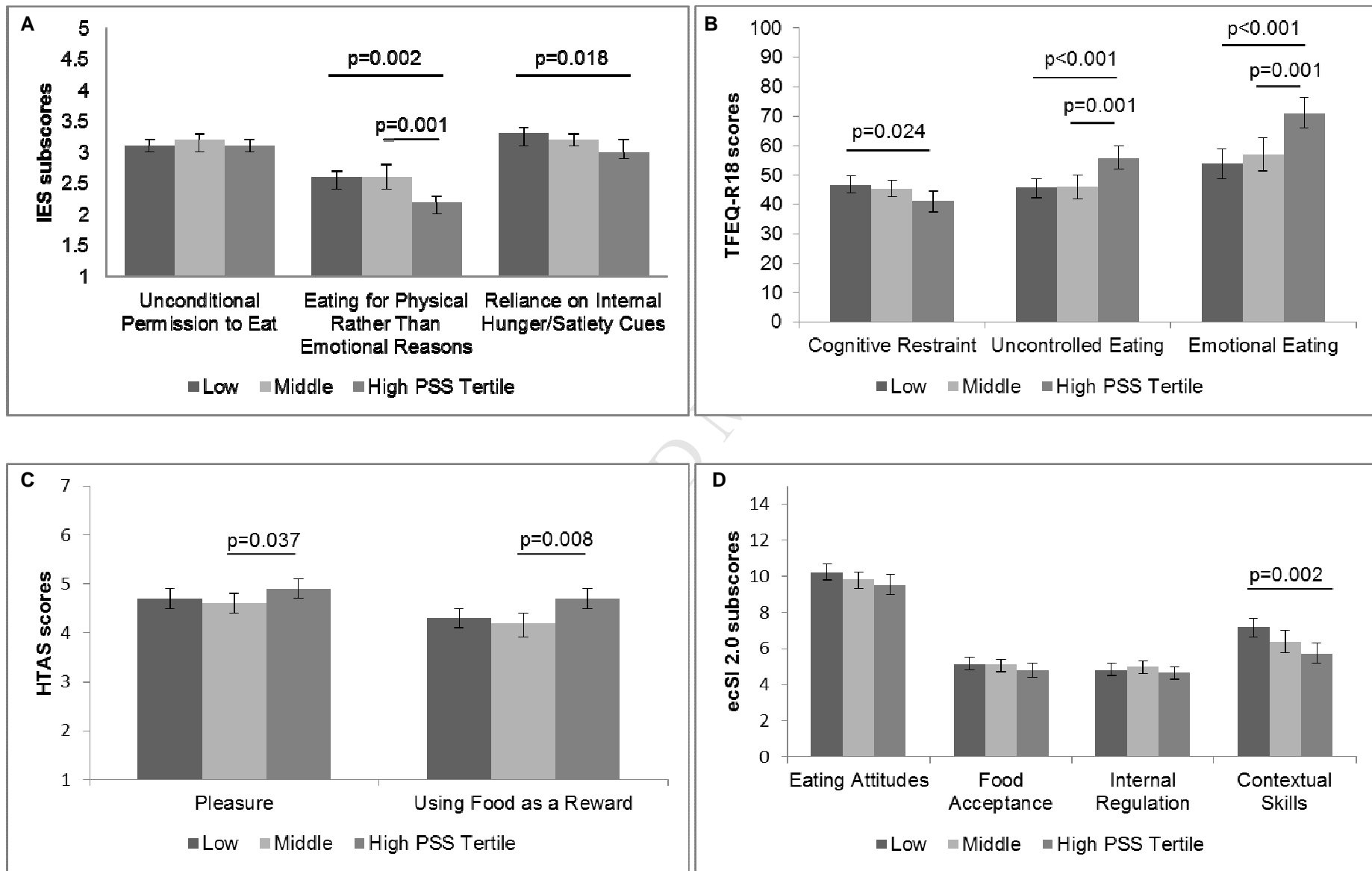
Characteristic	PSS Tertiles			p-value ^a
	Lowest (7 – 23) (n = 104)	Middle (24 – 30) (n = 102)	Highest (31 – 52) (n = 91)	
Starting time of the study (n)				
Autumn	50	43	49	0.267
Spring	54	59	42	
Study center (n)				
Jyväskylä	25	31	27	0.435
Kuopio	41	29	26	
Helsinki	38	42	38	
Gender (n)				
Female	87	85	77	0.969
Male	17	17	14	
Age (y)	48.9 ± 7.8	49.9 ± 7.4	47.8 ± 7.6	0.163
BMI (kg/m ²)	31.5 ± 2.8	31.1 ± 3.2	31.4 ± 3.1	0.577
Waist circumference (cm)	102.3 ± 8.1	103.4 ± 9.5	102.9 ± 8.6	0.674
Aim to lose weight (n)				
Yes	96	93	74	0.033
No	8	9	17	
Depression (BDI-II) (n)				
No/minimal	85	56	20	<0.001
Mild	17	37	27	
Moderate	2	9	37	
Severe	0	0	7	
Marital status (n)				
Married/cohabiting	84	76	61	0.090
Other ^b	20	26	30	

293 Notes: Values are n / mean ± SD; PSS = Perceived Stress Scale (possible score range 0 – 56); Autumn =
 294 September – October; Spring = January – February; BMI = body mass index; BDI-II = The Beck Depression
 295 Inventory-II.

296 ^a p-value for differences between the perceived stress tertiles (Pearson chi-square or Fisher's Exact test for
 297 categorical variables and one-way ANOVA for continuous variables).

298 ^b Unmarried, estranged, divorced or widow/widower.

299 Fig. 1. Subscales of eating behavior measures in the perceived stress tertiles.



300

301

302 Notes: Data are presented as mean \pm 95% confidence intervals. One-way ANOVA was used to compare
303 tertile means. P-values are for significant differences between the Perceived Stress Scale (PSS) tertiles
304 (Tukey HSD post hoc test, analyzed without adjustments). After adjusting for study center and starting time
305 of the study the differences in Pleasure were non-significant. (A) IES = Intuitive Eating Scale; (B) TFEQ-R18
306 = The Three-Factor Eating Questionnaire-R18; (C) HTAS = Health and Taste Attitude Scales; (D) ecSI 2.0 =
307 preliminary Finnish translation of Satter Eating Competence Inventory 2.0. Lowest tertile of PSS scores 7 –
308 23, n=104, middle tertile of PSS scores 24 – 30, n=102, and highest tertile of PSS scores 31 – 52, n=91.

309

310 After adjustment for study center and starting time of the study, the association of perceived stress with
311 seeking pleasure from food was not statistically significant ($F[2, 287]=1.74, p=0.178$) any more. Adjusting
312 further for aim to lose weight, the associations of perceived stress with seeking pleasure from food ($F[2,$
313 $286]=1.75, p=0.175$) and cognitive restraint ($F[2, 290]=2.41, p=0.092$) were not statistically significant any
314 more.

315 Fifty-eight (20%) participants were competent eaters (ecSI 2.0 total score ≥ 32). The difference in the
316 proportion of competent eaters in PSS tertiles was statistically significant ($\chi^2 (2) = 7.764, p=0.021$): nine
317 (16%) of the competent eaters were in the highest tertile of perceived stress whereas of the non-competent
318 eaters there were 34% (n=82).

319 Associations of food consumption and nutrient intake with perceived stress

320 There were no significant differences among the tertiles of perceived stress in energy nutrient intake or
321 alcohol use. A trend ($p=0.076$) was observed for lower IDQ score in the highest tertile of perceived stress,
322 but it did not remain after adjustment for study center and starting time of the study (Table 3). After
323 adjustment for study center and starting time of the study, the association of perceived stress with the
324 percentage of energy from saturated fat became statistically significant ($F[2, 287]=3.50, p=0.032$) but no
325 statistically significant differences between the tertiles were found in the post hoc analysis. Adjusting further
326 for gender or aim to lose weight, no statistically significant associations were found.

327

328

329 Table 3. Diet quality, alcohol use and intake of energy nutrients in the perceived stress tertiles.

	PSS Tertiles			p-value ^a	p-value ^b
	Lowest	Middle	Highest		
	(7 – 23) (n = 104)	(24 – 30) (n = 102)	(31 – 52) (n = 91)		
Diet quality and alcohol use					
IDQ score	10.4 ± 1.9 ^c	10.3 ± 2.1	9.8 ± 2.3	0.076	0.119
AUDIT-C score	3.6 ± 2.1	4.0 ± 2.6	4.0 ± 2.3	0.374	0.366
Intake of energy nutrients					
Energy (kJ)	8040 ± 2326	8289 ± 2520	8456 ± 2231	0.466	0.397
Protein (E%)	17.3 ± 3.5	17.9 ± 4.2	17.1 ± 4.5	0.336	0.488
Carbohydrate (E%)	41.5 ± 7.2	40.7 ± 7.9	40.3 ± 7.6	0.507	0.602
Total fat (E%)	37.3 ± 7.6	37.1 ± 8.4	38.2 ± 7.6	0.564	0.609
Saturated fat (E%)	13.2 ± 3.4	13.3 ± 3.7	14.3 ± 4.3	0.079	0.032
Monounsaturated fat (E%)	13.1 ± 3.6	12.6 ± 3.4	13.0 ± 3.0	0.521	0.536
Polyunsaturated fat (E%)	6.3 ± 1.9	6.4 ± 2.1	6.5 ± 2.3	0.804	0.704
Sucrose (E%)	9.6 ± 4.3	8.7 ± 5.1	9.1 ± 4.6	0.160	0.191
Fiber (g)	22.5 ± 8.2	23.9 ± 10.1	22.0 ± 9.4	0.292	0.402
Fiber (g/MJ)	2.9 ± 1.0	2.9 ± 1.0	2.6 ± 1.0	0.093	0.131

330 Notes: Values are mean ± SD; PSS = Perceived Stress Scale (possible score range 0 – 56); IDQ = Index of
 331 Diet Quality (possible score range 0 – 15); AUDIT-C = three alcohol consumption questions from the Alcohol
 332 Use Disorders Identification Test (possible score range 0 – 12); E% = percentage of energy.

333 ^a p-value for differences between the perceived stress tertiles (one-way ANOVA).

334 ^b p-value adjusted for study center and starting time (three-way independent ANOVA).

335 ^c n=103 because of one missing value in IDQ score.

336

337 Most participants (n=193, 65%) reported high adherence to the health-promoting diet (IDQ score ≥10). The
 338 adherence to the health-promoting diet did not differ significantly among PSS tertiles (69% in the lowest,
 339 67% in the middle, and 59% in the highest PSS tertile, χ^2 [2, N=296] = 2.106, p=0.349).

340 Intake of whole grain products as grams and energy-adjusted grams per megajoule was lower in the most
 341 stressed participants than in the less stressed participants ($p=0.040$ and $p=0.013$, respectively) (Table 4).
 342 There were no differences in the intake of vegetables, fruits and berries, rye bread, fish, sweet and savory
 343 pastries, and salty snacks and sweets among the PSS tertiles. Nevertheless, there was a tendency
 344 ($p=0.067$) for lower energy-adjusted intake of vegetables, fruits and berries in the highest PSS tertile than in
 345 the middle and the lowest tertiles (Table 4).

346

347 Table 4. Food consumption as grams and energy-adjusted grams per MJ in the perceived stress tertiles.

	PSS Tertiles			p-value ^a
	Lowest	Middle	Highest	
	(7 – 23) (n = 104)	(24 – 30) (n = 102)	(31 – 52) (n = 91)	
	Mean (95% CI)			
Vegetables				
g/day	205 (183 to 227)	192 (170 to 215)	190 (163 to 217)	0.423
g/MJ/day	27 (24 to 30)	24 (21 to 27)	24 (20 to 27)	0.167
Fruits and berries				
g/day	256 (215 to 297)	272 (216 to 329)	223 (180 to 267)	0.391
g/MJ/day	34 (28 to 40)	35 (28 to 43)	27 (22 to 32)	0.214
Vegetables, fruits and berries				
g/day	461 (414 to 509)	465 (403 to 527)	413 (357 to 470)	0.269
g/MJ/day	61 (54 to 68)	59 (51 to 67)	50 (44 to 57)	0.067
Rye bread				
g/day	55 (44 to 66)	63 (52 to 73)	57 (47 to 67)	0.359
g/MJ/day	7 (6 to 8)	8 (6 to 9)	7 (6 to 8)	0.370
Whole grain products				
g/day	141 (119 to 164)	151 (127 to 174)	114 (91 to 136)	0.040
g/MJ/day	18 (15 to 20)	19 (16 to 22)	14 (11 to 16)	0.013

Fish				
g/day	28 (20 to 35)	24 (16 to 32)	27 (18 to 35)	0.677
g/MJ/day	4 (3 to 4)	3 (2 to 4)	3 (2 to 4)	0.625
Pastries (sweet and savory)				
g/day	67 (52 to 82)	88 (63 to 113)	86 (64 to 107)	0.370
g/MJ/day	8 (6 to 10)	10 (8 to 12)	9 (7 to 11)	0.364
Salty snacks and sweets				
g/day	24 (17 to 30)	19 (13 to 24)	28 (20 to 36)	0.515
g/MJ/day	3 (2 to 4)	2 (2 to 3)	3 (2 to 4)	0.536

348 Notes: Values are average of two days consumption based on 48-h dietary recall. PSS = Perceived Stress

349 Scale (possible score range 0 – 56); CI = confidence interval for mean.

350 ^a p-value for differences between the perceived stress tertiles (Kruskall-Wallis test).

351

352 Associations of eating behavior, energy intake and perceived stress

353 As an additional information, the association of energy intake and perceived stress was analyzed according
 354 to the participants' ratings of stress-eating. Intuitive Eating Scale (IES) includes an item directly related to
 355 stress "I find myself eating when I am stressed out, even when I'm not physically hungry". Most of the
 356 participants strongly agreed (24%) or agreed (49%) with the statement whereas 11% disagreed and 5%
 357 strongly disagreed. These IES responses were associated with perceived stress ($\chi^2(8) = 21.507, p=0.006$)
 358 so that eating during stress was more common in the highest PSS tertile compared to the middle and the
 359 lowest tertiles. These IES responses were, however, not associated with actual energy intake in general
 360 ($F[4, 292]=0.365, p=0.834$) or separately in the PSS tertiles ($F[4, 99]=0.258, p=0.904$; $F[4, 97]=0.090,$
 361 $p=0.985$; and $F[4, 86]=0.123, p=0.974$ in the lowest, middle and highest tertile, respectively).

362

363 DISCUSSION

364 In the present study we found that higher level of perceived stress was associated with lower intuitive eating,
 365 lower eating competence and lower cognitive restraint, higher uncontrolled and emotional eating, and higher

366 tendency to use food as a reward in psychologically distressed overweight and obese working-age Finns
367 examined in a naturalistic setting. This was the first time, to the best of our knowledge, that favorable
368 characteristics of eating behavior, intuitive eating and eating competence, were shown to be rare among
369 overweight and obese adults with high perceived stress. The hypothesized association of perceived stress
370 with poorer diet quality was not confirmed although lower consumption of whole grain products among the
371 most stressed participants was found.

372 Consistently with our results, previous studies have found association between chronic or perceived stress
373 and higher uncontrolled (Groesz et al., 2012; Nevanpera et al., 2012; Richardson, Arsenault, Cates, & Muth,
374 2015) and emotional eating (Nevanpera et al., 2012; Richardson et al., 2015) in women. In the present study
375 of perceived stress the association was observed regardless of gender. In addition to previous studies, we
376 found that higher tendency to use food as a reward and seeking pleasure from food were associated with
377 higher perceived stress, although the latter association disappeared after adjusting with items related to
378 study design (i.e. study center, starting time of the study). This suggests that seeking pleasure from food at
379 the different levels of perceived stress was different between participants in three study centers and/or
380 between participants who answered the questionnaire in September – October and participants who
381 answered it in January – February. Lower cognitive restraint was associated with higher level of perceived
382 stress, but after adjusting for aiming to lose weight in addition to study center and starting time of the study,
383 the association did not remain significant. This suggests that cognitive restraint was different at the different
384 levels of perceived stress depending on whether a person is aiming to lose weight or not. This was logical,
385 since aim of losing or maintaining weight is, by definition, associated with cognitive restraint of eating (de
386 Lauzon et al., 2004) and the study participants with the highest level of perceived stress were also less
387 aiming to lose weight.

388 In addition to being associated with the unfavorable features of eating behavior, higher level of perceived
389 stress was inversely associated with the favorable features of eating behavior, intuitive eating and eating
390 competence. Individuals with high perceived stress were less likely to eat and drink according to their inner
391 feelings of hunger and satiety. Instead, their eating was more triggered by emotions and external cues. In
392 addition, lower contextual skills among those with the highest level of perceived stress indicate irregular meal
393 timing and planning for meals and less concentrating on eating. This could, in turn, be a risk factor for
394 uncontrolled eating and less successful weight management.

395 By using the cut-off value set in earlier studies (Lohse et al., 2007), minority (20%) of the participants were
396 competent eaters (having positive attitude towards eating and food, being willing to eat variety of foods,
397 consuming intuitively enough food, and manage daily meals (Satter, 2007)). The prevalence of competent
398 eaters was even smaller among the most stressed participants (10%). The proportion of competent eaters
399 was clearly lower than the prevalence of 29 – 46% found in previous studies in adult populations not
400 specifically targeted to psychologically distressed people (Krall & Lohse, 2010; Krall & Lohse, 2011; Lohse et
401 al., 2007; Psota et al., 2007). It could thus be speculated that either perceived stress reduces eating
402 competence or, vice versa, those with poor eating competence are more vulnerable to experience perceived
403 stress. Moreover, the most stressed study participants had the lowest eating competence but the highest
404 scores in emotional eating. It could thus be that eating is used for coping with negative feelings caused by
405 stress, and the emotional eating could thus be a moderator between perceived stress and eating
406 competence. However, these suggestions must be done with caution because of the cross-sectional study
407 design as well as because the preliminary Finnish translation of ecSI 2.0 used in this study has not been
408 validated in overweight and obese adults.

409 Our hypothesis that high perceived stress would be related to poorer diet was not confirmed. Higher
410 perceived stress was associated to a significant degree only with lower whole grain consumption. This
411 association has not been reported earlier. However, whole grain has been a part of an index or other
412 definition of “healthy diet” in a few previous studies investigating the association between stress and diet
413 (Groesz et al. 2012, Ferranti et al. 2013, Richardson et al. 2015). Persons with the highest perceived stress
414 in the present study showed, in addition, a tendency towards lower diet quality, higher percentage of energy
415 from saturated fat, and lower vegetable, fruit and berry consumption than persons with lower perceived
416 stress.

417 Although we found clear association between perceived stress and uncontrolled and emotional eating,
418 which, in turn, have been associated with non-beneficial food choices (Keskitalo et al., 2008; Kontinen et al.,
419 2010) and higher energy intake (de Lauzon et al., 2004), we found no marked associations between
420 perceived stress and food consumption or energy nutrient intake. This finding may be due to several
421 possible reasons. The overall dietary quality during the past month was measured by a short questionnaire,
422 and actual food and nutrient intake by a 48-h dietary recall. It may be possible that these measures were
423 incapable to detect the outcomes of certain features of eating behavior. For example, emotional eating may
424 lead to overeating (Wallis & Hetherington, 2009), but those overeating occasions may have not occurred

425 during the recorded 48 hours. Furthermore, Fridays and Saturdays were not included to the interviews which
426 may have influenced our results, as energy intake typically increases on weekends (Ocke et al., 2009;
427 Racette et al., 2008). Long-term stress among working-age people may increase eating after the workweek,
428 on Friday evenings and Saturdays. This stress-related overeating may be compensated by eating less or
429 paying attention to quality of food during weekdays or in the beginning of the working week (Racette et al.,
430 2008), which could explain our findings. Our results anyhow show that the possible stress-driven eating does
431 not have at least a clear, direct influence on food consumption during weekdays. To the best of our
432 knowledge, the weekday-weekend fluctuation has not been studied related to stress-driven eating. Some
433 indication of this could however be seen in two earlier studies with students, in which no differences were
434 observed between weekdays and weekend days in the association between perceived stress and hunger
435 (Huh, Shiyko, Keller, Dunton, & Schembre, 2015) or between the number of daily hassles and the number of
436 snacks consumed (Conner, Fitter, & Fletcher, 1999).

437 When measuring dietary intake, individuals tend to overestimate the intake of health-beneficial foods and
438 underestimate the non-beneficial foods. Especially obese persons are shown to underreport the use of
439 snack-type foods (Heitmann & Lissner, 1995) which particularly have been reported to be consumed under
440 stress (Groesz et al., 2012; Laitinen et al., 2002; Oliver & Wardle, 1999). In statistical analyses also energy
441 adjusted variables were used in order to try to handle underreporting. The possible misreporting was noticed
442 already in the creating of the 48-hour dietary recall interview protocol. Therefore, during the interview
443 participants were encouraged to be truthful, the situation was aimed to be confidential and non-judgmental,
444 and there were several possibilities for the interviewee to make changes to the record. An electronic picture
445 book was used to help estimate portion sizes and record them in a standardized way. Total avoidance of
446 misreporting food intake is challenging and would require more sophisticated methods such as continuous
447 food intake monitoring by e.g. a wearable camera or analyzing nutritional biomarkers from e.g. urine or blood
448 sample. In the present study, the high intake of vegetables, fruits, and berries (mean >400 g/day in each
449 PSS tertile) measured by the 48-h dietary recall and high adherence (65%) to the health-promoting diet
450 measured by IDQ questionnaire suggest that there could have been especially overreporting of health-
451 beneficial foods. Furthermore, only 20% were competent eaters, a classification which has been associated
452 with higher intake of fiber, several vitamins and minerals, and Healthy Eating Index (Lohse et al., 2012)
453 which also refers to potential overreporting. On the other hand, this could reflect the fact that majority (89%)
454 of the participants reported they were aiming to lose weight. In the whole sample, the overall intake of

455 carbohydrates as a proportion of energy was lower, intake of saturated fatty acids as a proportion of energy
456 was higher, and intake of fiber as both grams and energy-adjusted was lower than the current nutrition
457 recommendations (*Nordic nutrition recommendations 2012: Integrating nutrition and physical activity*2014)
458 which is common in Finnish adults (Helldán et al., 2013).

459 It is also important to take into consideration that approximately one third of people eat less than usual
460 during stress (Epel et al., 2004; Oliver & Wardle, 1999). It remains unclear how many participants in this
461 study population reacted to stress by decreasing eating and to what extent. For example, 73% reported that
462 when stressed they ate without experiencing physical hunger and this was more common among
463 participants with the highest perceived stress. But, inconsistently, the most stressed persons did not
464 consume more energy than less stressed.

465 Although several earlier studies have found association between stress and unfavorable diet quality or food
466 choices (Barrington et al., 2014; Groesz et al., 2012; Isasi et al., 2015; Oliver & Wardle, 1999; Wardle,
467 Steptoe, Oliver, & Lipsey, 2000), also opposite findings, in line with our results, have been reported.
468 Perceived stress has not been associated with diet quality measured by indices such as the Alternate
469 Healthy Eating Index (AHEI), the Dietary Approaches to Stopping Hypertension (DASH), the Mediterranean
470 Diet Score (Ferranti et al., 2013), and the Healthy Eating Index-2010 (HEI-2010) (Richardson et al., 2015), or
471 dietary energy density (Grossniklaus et al., 2010), intake of energy from added sugars (Barrington et al.,
472 2014), or omega-3 polyunsaturated fatty acids intake (Suominen-Taipale et al., 2010). Contradictory results
473 may be due to sample differences in gender, ethnic background, or socio-economic status, for example, and
474 different ways to measure stress and food consumption and nutrient intake as there is no standard method
475 for either of them.

476 It is also important to take into consideration that the timeframe of measured perceived stress and food
477 consumption and nutrient intake may not fully correspond with each other. Perceived Stress Scale does not
478 measure chronic stress but contains all the previous events that still influence appraised stress (Cohen et al.,
479 1983). Questions in Perceived Stress Scale and Index of Diet Quality concerned the previous month, and in
480 AUDIT-C the previous six months, whereas 48-hour dietary recall represents food consumption during a
481 shorter period of time. Nevertheless, we wanted to use 48-hour dietary recall to collect food consumption
482 data in as free-living situation as possible so that the measurement would not influence the study

483 participants' dietary intake. Perceived Stress Scale was used because we were interested in participants'
484 subjective experience of stress over a longer period of time.

485 In this study population, those in the highest perceived stress tertile were less aiming to lose weight and had
486 more depressive symptoms but there were no differences in gender, age, BMI, waist circumference, marital
487 status, number of underage children in household, education level, having regular medication, or type of
488 working hours between the different levels of perceived stress. Also Grossniklaus et al (Grossniklaus et al.,
489 2010) have found correlation between perceived stress and depressive symptoms in overweight working-age
490 people.

491 Strengths and limitations

492 This study was a cross-sectional analysis of the baseline measurements of psychologically distressed
493 overweight and obese persons attending a lifestyle intervention. Despite the fact that all the subjects were,
494 due to the inclusion criteria, psychologically distressed, they still had large variation in Perceived Stress
495 Scale (PSS) scores, which enabled us to investigate the association between the level of stress and features
496 of eating behavior and diet. Using a subjective measure of stress may be debated but in the same Elixir
497 study population higher perceived stress was found to associate with higher objective heart-rate-variability-
498 measured stress on workdays (Fohr et al., 2015). Rather a large sample size and multicenter design,
499 representing three areas in Finland, is also a strength of this study. Furthermore, the study population
500 consisted of ethnically homogenous Finnish population. It is important to study this topic also among
501 populations representing different cultures and ethnic backgrounds to find out whether the findings are
502 culture-specific or modified by ethnic background.

503 There were also limitations in our study. Participants filled in the electronic questionnaires on their own. This
504 could have encouraged them to answer more truthfully, but it has possibly also increased the
505 misunderstanding of the questions as the responses were not checked with the study personnel, except for
506 the Index of Diet Quality. It is also important to notice that the study population may have been biased, as
507 participants were rather highly educated and most of the participants were non-smokers, married or
508 cohabiting, and aiming to lose weight. Furthermore, the gender distribution did not correspond the typical
509 distribution of overweight and obesity in Finnish population, as overweight is more prevalent in males than
510 females and the prevalence of obesity is equal in both genders (Mannisto et al., 2015). Participants were

511 also overall interested in lifestyle changes as they all had enrolled in Elixir lifestyle intervention study
512 voluntarily. These all may affect the generalization of the study results.

513 **CONCLUSIONS**

514 This study provided unique information about the associations of both favorable and unfavorable features of
515 eating behavior and diet quality with perceived stress in psychologically distressed overweight and obese
516 Finns in a non-experimental, real-world context. As hypothesized, higher level of perceived stress was
517 associated with several unfavorable features of eating behavior, such as eating less according to hunger and
518 satiety cues and more according to emotions, but unexpectedly mainly not with the quality or content of the
519 diet measured by 48-h dietary recall of mostly weekdays, Index of Diet Quality, and AUDIT-C. This indicates
520 that either the methods used were incapable to detect stress-related eating or that this behavior may be
521 compensated during the weekdays. More research and methods development is needed concerning stress
522 and eating.

523 Highly stressed overweight and obese people were less aiming to lose weight and reported more and severe
524 depressive symptoms. Thus concentrating on psychological aspects and means for handling stress should
525 precede or be included in the nutritional lifestyle interventions and clinical care for this kind of population.
526 Higher prevalence of unfavorable eating behavior in highly stressed overweight and obese people may
527 indicate higher risk for lower quality of diet and unhealthy food choices in addition to difficulties in weight
528 management and eventually higher risk for metabolic health disturbances. More longitudinal research and
529 randomized controlled lifestyle interventions in this area are needed in order to develop efficient methods for
530 the clinicians to assist the overweight and obese patients to handle stress and improve unfavorable eating
531 behavior.

532

533 **Competing interests:** The authors declare that they have no competing interests.

534

535 **Acknowledgements**

536 The Elixir study was supported by the SalWe Research Program for Mind and Body (Tekes – the Finnish
537 Funding Agency for Technology and Innovation grant 1104/10). The preparation of this paper was also

538 supported by a personal grant (EJ-R) of The Diabetes Research Foundation, and by the PhD student
539 position (EJ-R) in the Doctoral Programme in Nutrition of the Faculty of Health Sciences, University of
540 Eastern Finland. The funding sources did not have a role in the study design, data collection, data analysis,
541 interpretation of the findings, writing of the article, or the decision to submit the paper for publication.

542 We would like to thank Sara Mutikainen and Urho Kujala (Department of Health Sciences, University of
543 Jyväskylä) and Elina Mattila (VTT Technical Research Centre of Finland, Tampere, Finland) who have
544 contributed to the Elixir study design and data collection; Eeva Lajunen, Erja Kinnunen, and Maritta
545 Putkiranta for skillful assistance in managing the study visits; Iina Grönberg, Saara Leino, Sinirikka Ventelä,
546 and Raisa Harjula for skillful participation in the conducting the practical period and handling dietary data;
547 Sini Lähteenmäki for data handling and revision, as well as Marianna Koivisto, Heidi Aaltonen and Saara
548 Peuhkuri for handling dietary data. We would also like to thank Salla Muuraiskangas for managing the
549 electronic questionnaires of the Elixir study and Anni Helldán (The National Institute for Health and Welfare,
550 Helsinki, Finland) for giving advice for the 48-hour dietary recall protocol development.

551

552

553

554

555

556

557

558

559

560

561

562

563

REFERENCES

- 564 Aalto, M., Alho, H., Halme, J. T., & Seppa, K. (2009). AUDIT and its abbreviated versions in detecting heavy
565 and binge drinking in a general population survey. *Drug and Alcohol Dependence*, *103*(1-2), 25-29.
566 doi:10.1016/j.drugalcdep.2009.02.013 [doi]
- 567 Barrington, W. E., Beresford, S. A., McGregor, B. A., & White, E. (2014). Perceived stress and eating
568 behaviors by sex, obesity status, and stress vulnerability: Findings from the vitamins and lifestyle
569 (VITAL) study. *Journal of the Academy of Nutrition and Dietetics*, *114*(11), 1791-1799.
570 doi:10.1016/j.jand.2014.03.015 [doi]
- 571 Beck, A. T., Steer, R. A., Ball, R., & Ranieri, W. (1996). Comparison of beck depression inventories -IA and -
572 II in psychiatric outpatients. *Journal of Personality Assessment*, *67*(3), 588-597.
573 doi:10.1207/s15327752jpa6703_13 [doi]
- 574 Bush, K., Kivlahan, D. R., McDonell, M. B., Fihn, S. D., & Bradley, K. A. (1998). The AUDIT alcohol
575 consumption questions (AUDIT-C): An effective brief screening test for problem drinking. Ambulatory
576 care quality improvement project (ACQUIP). Alcohol use disorders identification test. *Archives of*
577 *Internal Medicine*, *158*(16), 1789-1795.
- 578 Byrne, S. M. (2002). Psychological aspects of weight maintenance and relapse in obesity. *Journal of*
579 *Psychosomatic Research*, *53*(5), 1029-1036. doi:S0022399902004877 [pii]
- 580 Cohen, S. (2015). Dr. Cohen's Scales: Retrieved from <http://www.psy.cmu.edu/~scohen/scales.html>.
581 Accessed 30 July 2015.
- 582 Cohen, S., Kessler, R., & Gordon, U. (1997). *Strategies for measuring stress in studies of psychiatric and*
583 *physical disorders*. In S. Cohen, R. Kessler & U. Gordon (Eds.), *Measuring stress: A guide for health*
584 *and social scientists* (pp. 3-26) Oxford University Press, USA.
- 585 Cohen, S., Janicki-Deverts, D., & Miller, G. E. (2007). Psychological stress and disease. *Jama*, *298*(14),
586 1685-1687. doi:298/14/1685 [pii]
- 587 Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health*
588 *and Social Behavior*, *24*(4), 385-396.
- 589 Conner, M., Fitter, M., & Fletcher, W. (1999). *Stress and snacking: A diary study of daily hassles and*
590 *between-meal snacking*. *Psychol Health*, *14*(1), 51-63. doi:10.1080/08870449908407313
- 591 de Lauzon, B., Romon, M., Deschamps, V., Lafay, L., Borys, J. M., Karlsson, J., . . . Fleurbaix Laventie Ville
592 Sante Study Group. (2004). The three-factor eating questionnaire-R18 is able to distinguish among

- 593 different eating patterns in a general population. *The Journal of Nutrition*, 134(9), 2372-2380.
594 doi:134/9/2372 [pii]
- 595 Epel, E., Jimenez, S., Brownell, K., Stroud, L., Stoney, C., & Niaura, R. (2004). Are stress eaters at risk for
596 the metabolic syndrome? *Annals of the New York Academy of Sciences*, 1032, 208-210. doi:1032/1/208
597 [pii]
- 598 Ferranti, E. P., Dunbar, S. B., Higgins, M., Dai, J., Ziegler, T. R., Frediani, J. K., . . . Brigham, K. L. (2013).
599 Psychosocial factors associated with diet quality in a working adult population. *Research in Nursing &*
600 *Health*, 36(3), 242-256. doi:10.1002/nur.21532 [doi]
- 601 Fohr, T., Tolvanen, A., Myllymaki, T., Jarvela-Reijonen, E., Rantala, S., Korpela, R., . . . Kujala, U. M. (2015).
602 Subjective stress, objective heart rate variability-based stress, and recovery on workdays among
603 overweight and psychologically distressed individuals: A cross-sectional study. *Journal of Occupational*
604 *Medicine and Toxicology (London, England)*, 10, 39-015-0081-6. eCollection 2015. doi:10.1186/s12995-
605 015-0081-6 [doi]
- 606 Goldberg, D. (1972). *The detection of psychiatric illness by questionnaire. maudsley monograph no. 21.* .
607 Oxford: Oxford University Press.
- 608 Groesz, L. M., McCoy, S., Carl, J., Saslow, L., Stewart, J., Adler, N., . . . Epel, E. (2012). What is eating you?
609 stress and the drive to eat. *Appetite*, 58(2), 717-721. doi:10.1016/j.appet.2011.11.028 [doi]
- 610 Grossniklaus, D. A., Dunbar, S. B., Tohill, B. C., Gary, R., Higgins, M. K., & Frediani, J. (2010). Psychological
611 factors are important correlates of dietary pattern in overweight adults. *The Journal of Cardiovascular*
612 *Nursing*, 25(6), 450-460. doi:10.1097/JCN.0b013e3181d25433 [doi]
- 613 Heitmann, B. L., & Lissner, L. (1995). Dietary underreporting by obese individuals--is it specific or non-
614 specific? *BMJ (Clinical Research Ed.)*, 311(7011), 986-989.
- 615 Helldán, A., Raulio, S., Kosola, M., Tapanainen, H., Ovaskainen, M., & Virtanen, S. (2013). *Finravinto 2012 -*
616 *tutkimus – the national FINDIET 2012 survey.* (THL Report No. 16).
- 617 Herbert, B. M., Blechert, J., Hautzinger, M., Matthias, E., & Herbert, C. (2013). Intuitive eating is associated
618 with interoceptive sensitivity. effects on body mass index. *Appetite*, 70, 22-30.
619 doi:10.1016/j.appet.2013.06.082 [doi]
- 620 Holli, M. M., Marttunen, M., & Aalberg, V. (2003). Comparison of the GHQ-36, the GHQ-12 and the SCL-90
621 as psychiatric screening instruments in the finnish population. *Nordic Journal of Psychiatry*, 57(3), 233-
622 238. doi:10.1080/08039480310001418 [doi]

- 623 Huh, J., Shiyko, M., Keller, S., Dunton, G., & Schembre, S. M. (2015). The time-varying association between
624 perceived stress and hunger within and between days. *Appetite*, *89*, 145-151.
625 doi:10.1016/j.appet.2015.02.001 [doi]
- 626 Isasi, C. R., Parrinello, C. M., Jung, M. M., Carnethon, M. R., Birnbaum-Weitzman, O., Espinoza, R. A., . . .
627 Gallo, L. C. (2015). Psychosocial stress is associated with obesity and diet quality in Hispanic/Latino
628 adults. *Annals of Epidemiology*, *25*(2), 84-89. doi:10.1016/j.annepidem.2014.11.002 [doi]
- 629 Jaaskelainen, A., Nevanpera, N., Remes, J., Rahkonen, F., Jarvelin, M. R., & Laitinen, J. (2014). Stress-
630 related eating, obesity and associated behavioural traits in adolescents: A prospective population-based
631 cohort study. *BMC Public Health*, *14*, 321-2458-14-321. doi:10.1186/1471-2458-14-321 [doi]
- 632 Karlsson, J., Persson, L. O., Sjostrom, L., & Sullivan, M. (2000). Psychometric properties and factor structure
633 of the three-factor eating questionnaire (TFEQ) in obese men and women. results from the swedish
634 obese subjects (SOS) study. *International Journal of Obesity and Related Metabolic Disorders : Journal
635 of the International Association for the Study of Obesity*, *24*(12), 1715-1725.
- 636 Keskitalo, K., Tuorila, H., Spector, T. D., Cherkas, L. F., Knaapila, A., Kaprio, J., . . . Perola, M. (2008). The
637 three-factor eating questionnaire, body mass index, and responses to sweet and salty fatty foods: A twin
638 study of genetic and environmental associations. *The American Journal of Clinical Nutrition*, *88*(2), 263-
639 271. doi:88/2/263 [pii]
- 640 Konttinen, H., Mannisto, S., Sarlio-Lahteenkorva, S., Silventoinen, K., & Haukkala, A. (2010). Emotional
641 eating, depressive symptoms and self-reported food consumption. A population-based study. *Appetite*,
642 *54*(3), 473-479. doi:10.1016/j.appet.2010.01.014 [doi]
- 643 Krall, J. S., & Lohse, B. (2010). Cognitive testing with female nutrition and education assistance program
644 participants informs validity of the satter eating competence inventory. *Journal of Nutrition Education
645 and Behavior*, *42*(4), 277-283. doi:10.1016/j.jneb.2009.08.003 [doi]
- 646 Krall, J. S., & Lohse, B. (2011). Validation of a measure of the satter eating competence model with low-
647 income females. *The International Journal of Behavioral Nutrition and Physical Activity*, *8*, 26-5868-8-
648 26. doi:10.1186/1479-5868-8-26 [doi]
- 649 Laitinen, J., Ek, E., & Sovio, U. (2002). Stress-related eating and drinking behavior and body mass index and
650 predictors of this behavior. *Preventive Medicine*, *34*(1), 29-39. doi:10.1006/pmed.2001.0948 [doi]
- 651 Lappalainen, R., Sairanen, E., Jarvela, E., Rantala, S., Korpela, R., Puttonen, S., . . . Kolehmainen, M.
652 (2014). The effectiveness and applicability of different lifestyle interventions for enhancing wellbeing:

- 653 The study design for a randomized controlled trial for persons with metabolic syndrome risk factors and
654 psychological distress. *BMC Public Health*, 14, 310-2458-14-310. doi:10.1186/1471-2458-14-310 [doi]
- 655 Lee, E. H. (2012). Review of the psychometric evidence of the perceived stress scale. *Asian Nursing*
656 *Research*, 6(4), 121-127. doi:10.1016/j.anr.2012.08.004 [doi]
- 657 Leppala, J., Lagstrom, H., Kaljonen, A., & Laitinen, K. (2010). Construction and evaluation of a self-
658 contained index for assessment of diet quality. *Scandinavian Journal of Public Health*, 38(8), 794-802.
659 doi:10.1177/1403494810382476 [doi]
- 660 Lohse, B. (2015). The satter eating competence inventory for low-income persons is a valid measure of
661 eating competence for persons of higher socioeconomic position. *Appetite*, 87, 223-228.
662 doi:10.1016/j.appet.2014.12.228 [doi]
- 663 Lohse, B., Bailey, R. L., Krall, J. S., Wall, D. E., & Mitchell, D. C. (2012). Diet quality is related to eating
664 competence in cross-sectional sample of low-income females surveyed in pennsylvania. *Appetite*,
665 58(2), 645-650. doi:10.1016/j.appet.2011.11.022 [doi]
- 666 Lohse, B., Satter, E., Horacek, T., Gebreselassie, T., & Oakland, M. J. (2007). Measuring eating
667 competence: Psychometric properties and validity of the ecSatter inventory. *Journal of Nutrition*
668 *Education and Behavior*, 39(5 Suppl), S154-66. doi:S1499-4046(07)00690-2 [pii]
- 669 Mannisto, S., Laatikainen, T., Harald, K., Borodulin, K., Jousilahti, P., Kanerva, N., . . . Vartiainen, E. (2015).
670 Työikäisten ylipainon ja lihavuuden kasvu näyttää hidastuneen : Kansallisen FINRISKI-
671 terveystutkimuksen tuloksia (In Finnish with an English abstract. The trend towards increasing obesity
672 seems to have slowed down in the working aged Finnish population – Results from the National
673 FINRISK Studies). *Suomen Lääkärilehti. Finnish Medical Journal*, 70(14-15), 969-975.
- 674 Nevanpera, N. J., Hopsu, L., Kuosma, E., Ukkola, O., Uitti, J., & Laitinen, J. H. (2012). Occupational burnout,
675 eating behavior, and weight among working women. *The American Journal of Clinical Nutrition*, 95(4),
676 934-943. doi:10.3945/ajcn.111.014191
- 677 *Nordic nutrition recommendations 2012: Integrating nutrition and physical activity* (2014). (5th ed.).
678 Copenhagen: Nordic Council of Ministers.
- 679 Ocke, M. C., Larranaga, N., Grioni, S., van den Berg, S. W., Ferrari, P., Salvini, S., . . . Slimani, N. (2009).
680 Energy intake and sources of energy intake in the european prospective investigation into cancer and
681 nutrition. *European Journal of Clinical Nutrition*, 63 Suppl 4, S3-15. doi:10.1038/ejcn.2009.72 [doi]

- 682 Oliver, G., & Wardle, J. (1999). Perceived effects of stress on food choice. *Physiology & Behavior*, 66(3),
683 511-515. doi:S0031-9384(98)00322-9 [pii]
- 684 Paturi, M., Nieminen, R., Reinivuo, H., & Ovaskainen, M. (2006). *Ruokien annoskuvakirja*. (Publications of
685 the National Public Health Institute No. B11).
- 686 Psota, T. L., Lohse, B., & West, S. G. (2007). Associations between eating competence and cardiovascular
687 disease biomarkers. *Journal of Nutrition Education and Behavior*, 39(5 Suppl), S171-8. doi:S1499-
688 4046(07)00756-7 [pii]
- 689 Racette, S. B., Weiss, E. P., Schechtman, K. B., Steger-May, K., Villareal, D. T., Obert, K. A., & Holloszy, J.
690 O. (2008). Influence of weekend lifestyle patterns on body weight. *Obesity (Silver Spring, Md.)*, 16(8),
691 1826-1830. doi:10.1038/oby.2008.320 [doi]
- 692 Raikkonen, K., Matthews, K. A., & Kuller, L. H. (2007). Depressive symptoms and stressful life events predict
693 metabolic syndrome among middle-aged women: A comparison of world health organization, adult
694 treatment panel III, and international diabetes foundation definitions. *Diabetes Care*, 30(4), 872-877.
695 doi:30/4/872 [pii]
- 696 Richardson, A. S., Arsenault, J. E., Cates, S. C., & Muth, M. K. (2015). Perceived stress, unhealthy eating
697 behaviors, and severe obesity in low-income women. *Nutrition Journal*, 14(1), 122-015-0110-4.
698 doi:10.1186/s12937-015-0110-4 [doi]
- 699 Roininen, K., Lahteenmaki, L., & Tuorila, H. (1999). Quantification of consumer attitudes to health and
700 hedonic characteristics of foods. *Appetite*, 33(1), 71-88. doi:10.1006/appe.1999.0232 [doi]
- 701 Satter, E. (2007). Eating competence: Definition and evidence for the satter eating competence model.
702 *Journal of Nutrition Education and Behavior*, 39(5 Suppl), S142-53. doi:S1499-4046(07)00094-2 [pii]
- 703 Stewart-Knox, B. (2014). *Eating and stress at work: The need for public health promotion intervention and an*
704 *opportunity for food product development? . Trends Food Sci Technol*, 35(1), 52-60.
705 doi:http://dx.doi.org/10.1016/j.tifs.2013.10.010
- 706 Suominen-Taipale, A. L., Turunen, A. W., Partonen, T., Kaprio, J., Mannisto, S., Montonen, J., . . .
707 Verkasalo, P. K. (2010). Fish consumption and polyunsaturated fatty acids in relation to psychological
708 distress. *International Journal of Epidemiology*, 39(2), 494-503. doi:10.1093/ije/dyp386 [doi]
- 709 Torres, S. J., & Nowson, C. A. (2007). Relationship between stress, eating behavior, and obesity. *Nutrition*
710 *(Burbank, Los Angeles County, Calif.)*, 23(11-12), 887-894. doi:S0899-9007(07)00249-3 [pii]

- 711 Tylka, T. (2006). Development and psychometric evaluation of a measure of intuitive eating. *J Couns*
712 *Psychol*, 53(2), 226-240. doi:10.1037/0022-0167.53.2.226
- 713 Van Dyke, N., & Drinkwater, E. J. (2014). Relationships between intuitive eating and health indicators:
714 Literature review. *Public Health Nutrition*, 17(8), 1757-1766. doi:10.1017/S1368980013002139 [doi]
- 715 Wallis, D. J., & Hetherington, M. M. (2009). Emotions and eating. self-reported and experimentally induced
716 changes in food intake under stress. *Appetite*, 52(2), 355-362. doi:10.1016/j.appet.2008.11.007 [doi]
- 717 Wardle, J., Chida, Y., Gibson, E. L., Whitaker, K. L., & Steptoe, A. (2011). Stress and adiposity: A meta-
718 analysis of longitudinal studies. *Obesity (Silver Spring, Md.)*, 19(4), 771-778. doi:10.1038/oby.2010.241
719 [doi]
- 720 Wardle, J., Steptoe, A., Oliver, G., & Lipsey, Z. (2000). Stress, dietary restraint and food intake. *Journal of*
721 *Psychosomatic Research*, 48(2), 195-202. doi:S0022-3999(00)00076-3 [pii]
- 722