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Apple consumption is related to better sexual quality of life in young women

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Abstract
Introduction Even if some evidence exists of a positive correlation between regular intake of phytoestrogens, polyphenols, antioxidants and women's sexual health, there is not a study addressing the potential correlation between daily apple consumption and women's sexual function. We aim to assess whether there is a tie between daily apple intake and sexual function in a sample of healthy young sexually active Italian women, not complaining of any sexual disorders.
Materials and methods Seven hundred and thirty-one women (mean age 31.9, range 18–43) were enrolled in this cross-sectional study (from September 2011 to April 2012). All participants completed anonymously the Female Sexual Function Index (FSFI) and were asked to report on their amount of daily apple consumption and their eating habits. On the basis of apple consumption all women were split into two groups: Group A—regular daily apple consumption, Group B—no regular apple consumption (<1 apple/day). The main outcome measure was the FSFI questionnaire result.
Results Three hundred and forty-three women reported a regular daily apple intake and were classified in Group A, while 388 were included in Group B. Group A had a significantly higher total ($p = 0.001$; Cohen's $d = 3.39$) and lubrication domain ($p = 0.001$; Cohen's $d = 3.02$) FSFI

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scores than participants in Group B. Multivariate analysis demonstrated that daily apple intake must be considered as an independent parameter ($p = 0.002$) in predicting a better score at questionnaire examination.
Discussion This study suggests a potential relationship between regular daily apple consumption and better sexuality in our young women population.

Keywords Apple · Polyphenols · Mediterranean diet · Quality of life · Female sexual function · FSFI questionnaire

Introduction

Female sexuality is regulated by several anatomical, neurobiological, and psychological mechanisms and their interaction characterises the state of women's sexual response [1]. Several studies suggested that some foods could also have an intriguing impact on female sexual quality of life [2, 3]. Recently, Mondaini et al. [3] found that regular moderate intake of red wine is associated with higher FSFI scores for sexual desire, lubrication and overall sexual function as compared to teetotaller status. Moreover, Salonia et al. [2] showed that those women who reported eating ≥1 chocolate cubes daily have higher FSFI scores for both sexual desire and overall sexual function than women who did not report eating chocolate. The authors hypothesised that the reason for the impact of these foods on female sexuality may be the fact that foods containing polyphenols and antioxidant can stimulate peripheral vasodilation via activation of the nitric oxide system [2, 3]. During sexual arousal, in fact, the central reduction of sympathetic tone and the release of two vasodilator neurotransmitters (vasoactive intestinal peptide—VIP; nitric oxide—NO), create an increase in the blood flow to the external genitalia and vagina and promote relaxation of the smooth muscle of the cavernous sinuses in the clitoris [4]. Moreover, the vaginal capillaries of microcirculation are filled with blood and the increased hydrostatic pressure inside them forces out a plasma transudate (ultrafiltrate) in the interstitial space around the blood vessels [1]. Continued formation of this transudate fills up the interstitial space and then passes through and between the cells of vaginal epithelium to leak onto the surface wall of the vagina as the vaginal lubrication [1]. Another important factor determining normal vaginal lubrication and, generally, female sexuality, is estradiol. It is well known that postmenopausal reduction in estradiol is commonly associated with vaginal dryness, which improves with its replacement [5]. Recently, some authors have highlighted the fact that apples represent an important source of polyphenols and antioxidants in the Western diet. It has been suggested that their regular intake may result in human health benefits [6]. Moreover, it appears that apples contain phloridzin, a dihydrochalcone glycoside, and a common phytoestrogen [7]. It is well known that phytoestrogens, such as phloridzin, can produce oestrogen-like effects due to their structural similarity to estradiol, and can combine with oestrogen receptors in mammalians or humans, resulting in antioestrogenic or oestrogen-like activity [8]. In this sense, daily apple intake should improve female sexual quality of life. However, to the best of our knowledge, there is a lack of studies regarding the potential correlation between daily apple intake and women's sexual function. The aim of the present study is to evaluate if there is a tie between daily apple intake and sexual function in a sample of healthy young sexually active Italian women.

Subjects and methods

Study design

The present study was planned as cross-sectional, in line with the definition by Abramson and Abramson [9], to test the relationship between daily apple use and sexual quality of life in young women. We planned this study as cross-sectional due to the fact that this kind of study describes the relationship between health-related quality of life and other factors of interest in a specified population at a particular time, without regard to what may have preceded or precipitated the health status found at the time of the study. We recruited 731 women (mean age 31.9, range 18–43), living both in Tuscany and Trentino-Alto Adige, with no history or complaint of sexual disorder (from September 2011 to April 2012). All participants anonymously completed the Female Sexual Function Index (FSFI questionnaire), in accordance with Rosen et al. [10]. All patients were then split into two groups, in accordance with their daily apple intake: Group A—regular daily apple consumption, Group B—no regular apple consumption (<1 apple/day). No data about the apple type preferred were collected due to the difficulty in obtaining this type of information. We only enrolled women who declared they had eaten an apple without peeling it. Moreover, they were asked to describe their fruit consumption and eating habits and behaviours. In particular, they were asked to describe their vegetables and fruits consumption (pieces/day). Moreover, all subjects were asked to describe their regular physical activity (times/week). Data from the FSFI questionnaire were analysed in order to test the differences between the two groups. Group A was considered as the case group, while Groups B was considered as the control group. The ratio between case and control was established as at least 1:1. All patients were informed about the nature of the study. The study was conducted in accordance with the principles

of research involving human subjects as expressed in the Declaration of Helsinki. Women did not receive any compensation for participating in this study. Participation was, then, voluntary and anonymous. No physical examination or laboratory evaluations were carried out.

Inclusion and exclusion criteria

Subjects were recruited among all female members of our hospitals (two in Trentino-Alto Adige, three in Tuscany), 1 month after study adverting by posting fliers in the hospitals. Patients' characteristics consisted of age between 18 and 45 years, pre-menopausal status, absence of comorbidities, no medical treatments for pain, no genital anatomical deformity, no previous genitourinary surgery, no prescription drug use, regular sex life and singular sexual partner during the last 3 months. Furthermore, all women who had undergone therapy with antibiotics, antifungal medication, nonsteroidal anti-inflammatory drugs or steroids for 4 weeks prior to the study were excluded. Additional exclusion criteria were use of hormone therapy and pregnancy or lactation. Moreover, all women who were symptomatic for already known urinary or genital infections, or who had a medical history of vulvar itching, fissures, abnormal discharge and persistent pain at intercourse were also excluded. Finally, all women using or initiating antidepressant, anxiolytic, and other psychotropic medications were excluded, too.

Female sexual function index

The FSFI is a brief multidimensional validated scale for assessing sexual function in women, that includes 19 questions grouped in 6 domains (desire, subjective arousal, lubrication, orgasm, satisfaction, and pain) with a total score range between 2 and 36 with higher scores indicating better functions [10]. The questionnaires were self-administered during an informal interview.

Statistical analysis

As null hypothesis we assumed that there was no difference between the two groups in terms of FSFI scores. The main outcome measure was the FSFI questionnaire result. For sample characterization and assessment of the distribution of scores, descriptive statistics were used, including measures of central tendency (mean) and dispersion (standard deviation) for quantitative variables and frequency for categorical variables. All variables were subsequently coded for analysis as continuous or categorical in accordance to their characteristics. Data are, then, presented as the mean ± standard deviation (SD). We compared the two groups at the enrolment using a two-tailed Student's t test for paired/unpaired data and a Chi-squared analysis for the comparison of proportions. Spearman's rank correlation coefficient test has been used to calculate the correlation for continuous predictors and for ordinal predictors. The multivariate logistic regression was used for multivariate analysis adjusted for age, age of the menarche, age at the debut of sexual intercourse, smoking habits, body mass index and education level, to explore the effects of all parameters on FSFI questionnaire result. The effect size between the means (Cohen's d) was also calculated. The parameters considered for multivariate analysis were chosen in accordance with Cai et al. [11] and were as follows: place of living, use of condom or oral contraceptive, frequency of sexual intercourse, previous pregnancy, history of genital infection, healthy dietary habits (5 pieces/days of vegetables or fruits [12]), physical activity, daily apple intake and daily fruit intake. Patient characteristics considered for the statistical analysis were chosen in accordance with Mondaini et al. [3]. All variable of interest were collected during an informal interview and recorded in a dedicated database. Statistical significance was achieved if p was <0.05. All reported p values were two sides. All data were recorded, collected and analysed using SPSS 11.0 for Apple-Macintosh (SPSS, Inc., Chicago, IL, USA).

Results

803 consecutive sexually active women completed the questionnaire and were considered for the study. Seventy-two patients were excluded for lack of data collection. Finally, 731 patients (mean age 31.9, range 18–43) were enrolled. All anamnestic and clinical data at enrolment are shown in Table 1. The two groups were homogeneous in terms of anamnestic or demographic characteristics.

No women reported genitourinary symptoms. However, 31 patients in Group A (9.03 %) and 35 in Group B (9.02 %) reported occasional and unjustified pain at sexual intercourse (Table 1). No statistically significant difference between two groups, in terms of reported pain, was found ($p = 0.99$).

Daily apple use

Group A women reported a daily median apple intake of 1 (ranging from 1 to 2), while Group B 0 (ranging from 0 to 0.5). Most women in Group B reported intake of 1 apple every 2 days or more.

FSFI results

Table 2 gives the FSFI scores, in accordance with all two groups. Group A had significantly higher total (27.9 ± 5.4)

Table 1 Demographic, anamnestic and clinical data at enrolment

Enrolled subjects	731		*p*
	Group A	Group B	
Participants	343	388	
Age mean ± SD	31.7 ± 2.2	32.1 ± 4.1	0.10
Age at the debut of sexual intercourse mean ± SD	17.3 ± 4.2	16.8 ± 4.1	0.09
Age of the menarche ± SD	11.5 ± 5.1	12.3 ± 5.9	0.06
Place of living			
Tuscany	195 (56.8)	201 (51.8)	0.17
Trentino-Alto Adige	148 (43.2)	187 (48.2)	
Education level			
Primary school	78 (22.7)	85 (21.9)	
Secondary school	92 (26.9)	103 (26.7)	0.69
High school	112 (32.7)	124 (31.9)	
University	61 (17.7)	76 (19.5)	
Smoking habitus			
Current smoker	67 (19.5)	79 (20.4)	
Former smoker	93 (27.1)	112 (28.8)	0.38
Never smoker	183 (53.4)	197 (50.8)	
Daily median apple intake (range)	1 (1–2)	0 (0–0.5)	–
Daily median fruit intake ± SD	1.8 ± 1.1	1. ± 1.2	0.19
Physical activity ± SD (times/week)	2.1 ± 2.9	1.8 ± 2.7	0.14
Dietary habits			
Healthy dietary habits	135 (39.3)	156 (40.2)	0.82
BMI (kg/m^2) mean ± SD	22.9 ± 3.9	22.4 ± 3.2	0.06
Contraceptive use			
Oral contraceptive	103 (30.1)	109 (28.1)	
Condom	108 (31.4)	116 (29.9)	0.61
Coitus interruptus	75 (21.8)	92 (23.7)	
Nothing	57 (16.7)	71 (18.3)	
Frequency of sexual intercourse (times to weeks)			
1	30 (8.7)	40 (10.3)	0.41
≥2	313 (91.3)	348 (89.7)	
Previous pregnancy			
Yes	76 (22.2)	93 (23.9)	0.62
No	267 (77.8)	295 (76.1)	
History of genital infection (STDs)			
Yes	97 (28.3)	126 (32.5)	0.25
No	246 (71.7)	262 (67.5)	

The table shows all patient anamnestic and clinical characteristics at enrolment time

All data are frequencies, where not otherwise specified

SD standard deviation, *BMI* body mass index, *STDs* sexually transmitted diseases

(Cohen's $d = 3.39$) ($p = 0.001$) and lubrication domain (4.4 ± 3.8) (Cohen's $d = 3.02$) ($p = 0.001$) FSFI scores than participants in Group B. No significant differences between the two groups were observed concerning desire ($p = 0.57$), sexual arousal ($p = 0.91$), satisfaction ($p = 0.79$), pain ($p = 0.52$) and orgasm ($p = 0.86$). At multivariate analysis daily apple intake was identified as an independent parameter ($p = 0.002$) in predicting the better score at questionnaire examination, in our female population. Table 3 shows the results of the multivariate analyses. No correlation has been found between apple use and physical activity practice (times per week) ($p = 0.76$). Finally, both Group A women and Group B reported consumption of about two fruit pieces/day (Group A: 1.8 ± 1.1; Group B: 1.7 ± 1.2). No differences in daily fruit consumption were found ($p = 0.19$).

Table 2 Female sexual function index questionnaire results according to the Groups

FSFI domains	Group 1	Group 2	*p*/Cohen's *d*
Desire	4.4 ± 3.8	3.9 ± 3.1	0.06/0.82
Arousal	4.4 ± 4.4	4.3 ± 4.6	0.76/0.14
Lubrification	4.4 ± 3.8	2.2 ± 2.9	0.001/3.02
Orgasm	4.7 ± 2.1	4.5 ± 2.2	0.21/0.25
Satisfaction	4.3 ± 2.1	4.5 ± 1.8	0.06/−0.3
Pain	4.1 ± 4.2	4.7 ± 4.1	0.06/−0.9
Total	27.9 ± 0.9	24.1 ± 6.7	0.001/3.39

The table shows all female sexual function index questionnaire results

Data are presented as the mean ± standard deviation (±SD)

Discussion

The correlation between daily apple intake and higher FSFI scores for lubrication and overall sexual function as compared to those who did not report eating apples is intriguing. Even if these findings need to be interpreted with some caution, due to the small number of women, self reported data and the lack of laboratory exams, it nevertheless suggests the presence of a relationship between daily apple use and a better sexual function as evidenced in the multivariate analysis. It is well known that female sexual function is a complex neurovascular phenomenon under psychological and hormonal control, but it has been demonstrated that some foods, containing polyphenols and antioxidant, are able to have a significant impact on it [2, 3]. Apples, for instance, contain a lot of pharmacologically active substances such as phytoestrogens, polyphenols and antioxidants [6, 13, 14]. In fact, apples are large contributors of phenolic compounds in European and North American diets [6]. Several studies have demonstrated that consumption of apples has been linked to the prevention of chronic disease. Particularly, apple intake has been negatively associated with lung cancer incidence [15, 16], coronary and total mortality [17], symptoms of chronic obstructive pulmonary disease [18], and risk of

Table 3 Multivariate analysis results of factors affecting female sexual quality of life (FSFI score results)

Categories (variables)	Multivariate analysis		
	Crude OR (95 % CI)	Adjusted[a] OR (95 % CI)	*p* value
Place of living	1.02 (0.43–1.71)	1.20 (0.50–1.87)	0.07
Daily apple intake	3.10 (2.21–3.90)	4.41 (2.31–6.85)	0.002
Daily fruit intake	1.32 (0.65–1.77)	1.43 (0.80–1.83)	0.09
Physical activity	0.71 (0.53–1.23)	1.10 (0.70–1.51)	0.12
Healthy dietary habits	0.71 (0.36–1.31)	1.12 (0.76–1.41)	0.20
Oral contraceptive	0.94 (0.58–1.39)	1.11 (0.61–1.67)	0.31
Use of condom	1.45 (0.85–1.67)	1.50 (0.76–1.65)	0.07
Frequency of sexual intercourse	1.22 (0.75–1.56)	1.34 (0.84–1.45)	0.09
Previous pregnancy	1.19 (0.87–1.47)	1.45 (0.67–1.59)	0.31
History of genital infection	0.74 (0.49–1.29)	1.06 (0.51–1.31)	0.33

The table shows the multivariate analysis results of factors affecting female sexual quality of life (female sexual function index results)

The model included place of living, daily apple intake, daily fruit intake, physical activity, healthy dietary habits, oral contraceptive use, use of condom, frequency of sexual intercourse, previous pregnancy and history of genital infection

We tested all first order interaction terms, and identified no confounders

OR odds ratio, *CI* 95 % confidence interval

[a] Adjusted: values corrected for age, age of the menarche, age at the debut of sexual intercourse, smoking habitus, body mass index and education level

thrombotic stroke [19]. It is also well known that the concentration of total phenolic compounds is much greater in the peel of apples than in the flesh [20]. For this reason, we only enrolled women who declared they ate apples without peeling them. It might be interesting to evaluate whether apple peel has a modifying effect on female sexual quality of life. It should be the aim of a future study. Another peculiar finding in our cohort of women was the lack of correlation between overall sexual function and the living area. No difference was found between the women living in Tuscany and those in Trentino-Alto Adige. This aspect supports the hypothesis and our findings that daily apple intake is an independent factor affecting female sexual quality of life. Recently, a Mediterranean-style diet carried out for 2 years was claimed to be effective in ameliorating sexual function in women with metabolic syndrome but the exact mechanism remains unclear [21]. The authors claim that food rich in fibres and antioxidants is the key point of female sexual function changes in multivariate analysis [21]. Finally, this study shows a few limitations that should be taken into account. We cannot exclude that unexpected selection bias due to cultural and socioeconomic status may have affected participation in this study. Furthermore, we cannot exclude that respondents who agree to complete the questionnaires might have been more sexually active per se, that is, have the highest sexual desire profile, and also hold different food-related attitudes than those who did not agree to complete the questionnaires. Moreover, as suggested by Salonia et al. [2], because both health and taste factors are important in the food choice process, dedicated tools for studying these aspects of food choices are required. Moreover, another aspect should be taken into account in the current findings interpretation. Sexual life is a complex phenomenon and as such is definitely affected by the individual's mental/psychological/psychiatric background. In particular, depression is mainly related to decreased sexual function. In this study we enrolled all participants referring mainly to patients' medical or surgical history without dedicated questionnaires to assess a possible psychiatric background. However, we excluded all women with clinical suspicion of depression or other mental/psychological/psychiatric diseases, basing on anamnesis and clinical history. However, further studies will be necessary to clarify all molecular mechanisms involving the relationship between apple intake and female sexuality. Further epidemiological investigations prospectively evaluating larger cohort populations of women are needed to confirm the precise role of apple intake in the context of female sexual response.

Conclusion

In conclusion, daily apple use is associated with higher FSFI scores in sexually active female patients thus increasing their lubrication and overall sexual function. Although these findings need to be interpreted with some caution due to the small patient sample size and the other limitations, daily apple intake could improve sexual quality of life in young sexually active women.

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Conflict of interest The authors declare no conflict of interest.

References

1. Salonia A, Giraldi A, Chivers ML et al (2010) Physiology of women's sexual function: basic knowledge and new findings. J Sex Med 7:2637–2660
2. Salonia A, Fabbri F, Zanni G et al (2006) Chocolate and women's sexual health: an intriguing correlation. J Sex Med 3:476–482
3. Mondaini N, Cai T, Gontero P et al (2009) Regular moderate intake of red wine is linked to a better women's sexual health. J Sex Med 6:2772–2777
4. Maravilla KR, Heiman JR, Garland PA et al (2003) Dynamic MR imaging of the sexual arousal response in women. J Sex Marital Ther 29:71–76
5. Rymer J, Morris EP (2000) Extracts from "clinical evidence": menopausal symptoms. BMJ 321:1516–1519
6. Wolfe K, Wu X, Liu RH (2003) Antioxidant activity of apple peels. J Agric Food Chem 51:609–614
7. Lauren DR, Smith WA, Adaim A et al (2009) Chemical composition and in vitro anti-inflammatory activity of apple phenolic extracts and of their sub-fractions. Int J Food Sci Nutr 60:188–205
8. Wang J, Chung MH, Xue B, Ma H, Ma C, Hattori M (2010) Estrogenic and antiestrogenic activities of phloridzin. Biol Pharm Bull 33:592–597
9. Abramson JH, Abramson ZH (2000) Survey methods in community medicine, 5th edn. Livingstone, Edinburgh, pp 171–183
10. Rosen R, Brown C, Heiman J et al (2000) The female sexual function index (FSFI): a multidimensional self-report instrument for the assessment of female sexual function. J Sex Marital Ther 26:191–208
11. Cai T, Mondaini N, Migno S et al (2011) Genital *Chlamydia trachomatis* infection is related to poor sexual quality of life in young sexually active women. J Sex Med 8:1131–1137
12. Marcus AC, Heimendinger J, Berman E et al (2005) A case study in dissemination: lessons learned from a pilot study involving the National Cancer Institute's Cancer Information Service. J Health Commun 10:219–233
13. Boyer J, Liu RH (2004) Apple phytochemicals and their health benefits. Nutr J 3:5
14. Martin JH, Crotty S, Warren P, Nelson PN (2007) Does an apple a day keep the doctor away because a phytoestrogen a day keeps the virus at bay? A review of the anti-viral properties of phytoestrogens. Phytochemistry 68:266–274
15. Knekt P, Järvinen R, Seppänen R et al (1997) Dietary flavonoids and the risk of lung cancer and other malignant neoplasms. Am J Epidemiol 146:223–230
16. Le Marchand L, Murphy SP, Hankin JH, Wilkens LR, Kolonel LN (2000) Intake of flavonoids and lung cancer. J Natl Cancer Inst 92:154–160
17. Knekt P, Jarvinen R, Reunanen A, Maatela J (1996) Flavonoid intake and coronary mortality in Finland: a cohort study. BMJ 312:478–481
18. Tabak C, Arts IC, Smit HA, Heederik D, Kromhout D (2001) Chronic obstructive pulmonary disease and intake of catechins, flavonols, and flavones: the MORGEN study. Am J Respir Crit Care Med 164:61–64
19. Knekt P, Isotupa S, Rissanen H (2000) Quercetin intake and the incidence of cerebrovascular disease. Eur J Clin Nutr 54:415–417
20. Escarpa A, González MC (1998) High-performance liquid chromatography with diode-array detection for the determination of phenolic compounds in peel and pulp from different apple varieties. J Chromatogr A 823:331–337
21. Esposito K, Ciotola M, Giugliano F et al (2007) Mediterranean diet improves sexual function in women with the metabolic syndrome. Int J Impot Res 19:486–491