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Changes in beverage consumption from pre-pregnancy to early pregnancy in the Norwegian Fit for Delivery study

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Abstract

Objective: To describe changes in consumption of different types of beverages from pre-pregnancy to early pregnancy, and to examine associations with maternal age, educational level and BMI.

Design: Cross-sectional design. Participants answered an FFQ at inclusion into a randomized controlled trial, the Fit for Delivery (FFD) trial, in median gestational week 15 (range: 9–20), reporting current consumption and in retrospect how often they drank the different beverages pre-pregnancy.

Setting: Eight local antenatal clinics in southern Norway from September 2009 to February 2013.

Subjects: Five hundred and seventy-five healthy pregnant nulliparous women.

Results: Pre-pregnancy, 27 % reported drinking alcohol at least once weekly, compared with none in early pregnancy ($P<0{\cdot}001$). The percentage of women drinking coffee (38 % *v.* 10 %, $P<0{\cdot}001$), sugar-sweetened beverages (10 % *v.* 6 %, $P=0{\cdot}011$) and artificially sweetened beverages (12 % *v.* 9 %, $P=0{\cdot}001$) at least daily decreased significantly from pre-pregnancy to early pregnancy, while the percentage of women who reported to drink water (85 % *v.* 92 %, $P<0{\cdot}001$), fruit juice (14 % *v.* 20 %, $P=0{\cdot}001$) and milk (37 % *v.* 42 %, $P=0{\cdot}001$) at least daily increased significantly. From pre-pregnancy to early pregnancy higher educated women reduced their consumption frequency of coffee significantly more than women with lower education. Older women reduced their consumption frequency of coffee and artificially sweetened beverages and increased their consumption frequency of fruit juice and milk significantly more than younger women.

Conclusions: There is a significant change in beverage consumption from pre-pregnancy to early pregnancy among Norwegian nulliparous women.

Keywords
Beverage consumption
Dietary change
Pregnant women

Maternal diet before and during pregnancy is important for the immediate and future health of the mother and child. Diet can modulate the developing nervous system as well as fetal expression of genes[1,2]. The mother's change in dietary behaviour during pregnancy may affect future food habits in the family[3]. There is also emerging knowledge on the effect of toxic dietary substances and non-nutrients on fetal health[4–8]. Thus, women's nutrition both pre-pregnancy and in pregnancy is an important public health issue[9] and this time period is regarded as a 'window of opportunity' when most women are highly motivated for dietary improvements[10,11].

The Norwegian public health authorities give general advice on a balanced and healthy diet. Women who plan to get pregnant and pregnant women are advised not to consume alcohol. Pregnant women are told to drink water when thirsty, to drink one to two glasses of skimmed or semi-skimmed milk and not more than two cups of coffee per day. One glass of fruit juice is regarded as 'one fruit' in the recommended 'five fruit and vegetables a day'. On the other hand, pregnant women are told to minimize intake of beverages that contain high amounts of sugar, listing fruit juice and sugar-sweetened beverages (SSB) as examples. There is no specific advice on consumption of artificially sweetened beverages (ASB)[12].

In order to tailor nutritional education and intervention policy to improve pregnant women's diet, knowledge about women's pre-pregnancy diet and also changes in dietary habits upon entering into pregnancy is essential. Furthermore, it is important to identify particular groups

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of pregnant women who have poor adherence to dietary recommendations to enable targeted nutritional education.

Beverages are a natural part of daily diet[13] and are an important source of nutrients, energy and fluids. However, some beverages like wine and coffee contain toxic substances. Longitudinal studies on diet across the transition to motherhood find that women report changes both in beverage intake and drinking behaviour[14,15]. Much of the research on beverage consumption during pregnancy has focused on specific types of drinks[5–7,16–27] or has been part of studies on nutrition during pregnancy[15,28–33]. Few, if any, studies have looked specifically at a broader range of beverage intake from pre-pregnancy to early pregnancy.

We aimed to describe beverage consumption and changes in beverage consumption from pre-pregnancy to the first appointment at the local antenatal clinic in a cohort of healthy Norwegian nulliparous women, and to examine potential associations between change in beverage consumption and maternal age, educational attainment and BMI.

Materials and methods

Population and study design

The present article is a baseline paper from the Norwegian Fit for Delivery (FFD) randomized controlled trial, where the intervention was antenatal nutritional counselling and exercise classes given to nulliparous women from the general population. The main aims of the FFD trial are to examine the effect of the intervention on maternal gestational weight gain, newborn birth weight, glucose regulation during pregnancy, complications of pregnancy and delivery, and postpartum maternal weight retention. The FFD trial has previously been described in detail[34]. The results from the present study are important for identifying maternal characteristics of particular importance as confounding factors in future evaluation of possible effects of the intervention. Pregnant nulliparous women were consecutively recruited from eight local antenatal clinics around Kristiansand in southern Norway from September 2009 to February 2013. Additional inclusion criteria were age ≥ 18 years, singleton pregnancy, gestational age less than 20 weeks, BMI $\geq 19{\cdot}0$ kg/m^2 and that the woman was fluent in Norwegian or English. Women with diabetes mellitus, ongoing substance abuse, physical disability that precluded participation in a physical fitness programme and planned relocation outside the study area before delivery were excluded.

At inclusion, in median gestational week 15 (range: 5–20), the women answered an FFQ. The study design was cross-sectional as the women reported how often they consumed the different drinks at inclusion and in retrospect how often they drank the different beverages before they got pregnant.

Assessment of dietary changes

Questionnaire items on beverage intakes included three items on milk (whole milk, low-fat or extra low-fat, and skimmed milk), two items on water (tap and bottled) and one item each on alcohol, coffee, SSB, ASB and fruit juice, respectively. The questionnaires were available in both paper and online versions. The majority chose to fill in the questionnaire electronically. All items had ten response alternatives and were recoded into frequency of consumption (0 = 'never', 0·5 = 'less than once a week', 1 = 'weekly', 2 = 'twice weekly', … 6 = 'six times weekly', 7 = 'daily' and 10 = 'several times daily'). The two items of water were pooled into one item labelled 'water', and the three items of milk were pooled into one item labelled 'milk'. The frequencies of beverage consumption for all beverages except alcohol were categorized into three groups: (i) ≤ 1/week, (ii) 2–6/week and (iii) ≥ 1/d to describe the distribution of beverage consumption pre-pregnancy and in early pregnancy. Alcohol was categorized as: (i) never, (ii) less than once weekly, (iii) weekly and (iv) twice weekly or more. Additionally, the frequencies of beverage consumption were categorized into two groups: $\geq$ daily ('at least daily') *v.* $<$ daily to examine potential associations between change in beverage consumption and maternal age, educational attainment and BMI.

Other study variables

A questionnaire regarding lifestyle and background factors was also filled in at inclusion. Study variables included maternal age at inclusion, pre-pregnancy BMI and length of education. Maternal age was dichotomized into <25 years *v.* ≥ 25 years. Height was measured to the nearest centimetre at the 30-week assessment, using a Seca Leicester portable stadiometer with an accuracy of 0·1 cm. Weight prior to pregnancy was self-reported and used for calculation of pre-pregnancy BMI (weight/height^2). According to the WHO definition of normal weight and overweight/obese[35], we dichotomized into BMI $<$ 25·0 kg/m^2 and BMI $\geq 25{\cdot}0$ kg/m^2. The included women were asked to report their level of education by choosing one of the following response options: 'less than 7 years of primary education', '7–10 years of primary education', '10–12 years of education', 'trade school or 1–2 years of high school', 'completed high school', 'less than 4 years at college/university' and '4 years or more at college/university'. Education was dichotomized into low education (did not attend college or university) and high education (having attended college or university).

Statistical methods

Student's *t* test and χ^2 statistics were used as appropriate to compare responders and non-responders. Furthermore, beverage consumption and the changes in beverage consumption from pre-pregnancy to median gestational week 15 were analysed with a multilevel linear mixed model with dichotomized beverage consumption variables as the dependent variables[36]. According to present

literature there might be a difference in pregnant women's beverage consumption depending on age, educational level and BMI[22,31,37]. Thus, the model included maternal age, BMI and educational level, as well as the interaction terms time × age, time × maternal education and time × BMI, to investigate changes in the consumption of different beverages from pre-pregnancy to median gestational week 15. The analyses were performed with the statistical software package IBM SPSS Statistics 19·0. Statistical analyses were conducted as two-tailed tests with a 0·05 level of significance.

Results

Sociodemographic characteristics

The inclusion of 575 pregnant women was per protocol and is shown in Fig. 1. Sociodemographic characteristics are described in Table 1. Mean maternal age was 28·1 (SD 4·35) years and mean pre-pregnant BMI was 23·9 (SD 3·83) kg/m^2.

Beverage consumption

Changes in the frequency of beverage consumption from pre-pregnancy to early pregnancy are presented in Fig. 2.

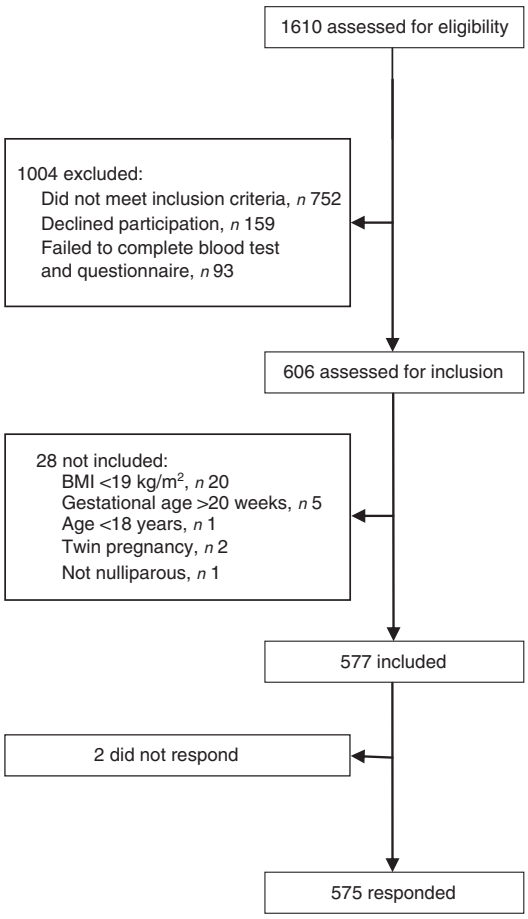

Fig. 1 Flow diagram of the inclusion of pregnant women in the present study

The percentage of women drinking coffee (38 % *v.* 10 %, $P<0·001$), SSB (10 % *v.* 6 %, $P=0·011$) and ASB (12 % *v.* 9 %, $P=0·001$) at least daily decreased significantly from pre-pregnancy to early pregnancy, while the percentage of women who reported at least daily consumption of water (85 % *v.* 92 %, $P<0·001$), fruit juice (14 % *v.* 20 %, $P=0·001$) and milk (37 % *v.* 42 %, $P=0·001$) increased significantly (Table 2). Pre-pregnancy, 11 % were abstaining from alcohol, 62 % reported drinking alcohol less frequently than once weekly, whereas 16 % were drinking alcohol weekly and 11 % reported drinking alcohol twice weekly or more. In early pregnancy, 99·7 % were abstaining from alcohol and 0·3 % reported drinking alcohol less frequently than once weekly, whereas no women reported drinking alcohol weekly or twice weekly or more.

Women with higher educational attainment reduced their frequency of at least daily coffee consumption (46 % *v.* 12 %) significantly more than women with lower educational attainment (31 % *v.* 9 %; interaction time × education, $P=0·005$). Older women (≥25 years) reported a significantly larger decrease in at least daily consumption of ASB (17 % *v.* 11 %) compared with younger women (7 % *v.* 7 %; interaction time × age, $P=0·045$). Furthermore, older women increased their frequency of at least daily consumption of fruit juice from pre-pregnancy to early pregnancy (17 % *v.* 27 %) significantly more than women aged <25 years (11 % *v.* 13 %; interaction time × age, $P=0·029$; Table 2). Additionally, older women reported a significantly larger increase in at least daily intake of milk from pre-pregnancy to early pregnancy (35 % *v.* 43 %) compared with younger women (39 % *v.* 40 %; interaction time × age, $P=0·041$). No significant interactions were observed between BMI and changes in drinking habits from pre-pregnancy to gestational week 15 (Table 2).

Table 1 Sociodemographic characteristics at inclusion among healthy, pregnant, nulliparous women (*n* 575), Norwegian Fit for Delivery (FFD) trial, September 2009 to February 2013

	n	%
Maternal age (years)		
<20	8	1·4
20–24	136	23·7
25–29	263	45·7
30–34	127	22·1
≥35	41	7·1
BMI (kg/m^2)		
19·0–<20·0*	60	10·4
20·0–<25·0	346	60·2
25·0–<30·0	126	21·9
≥30·0	43	7·5
Education (*n* 574)		
<7 years	0	0·0
7–10 years	9	1·6
10–12 years	74	12·9
Completed high school	97	16·9
<4 years college/university	190	33·1
≥4 years college/university	204	35·5

*Women had to have BMI ≥19·0 kg/m^2 to be included in the FFD trial.

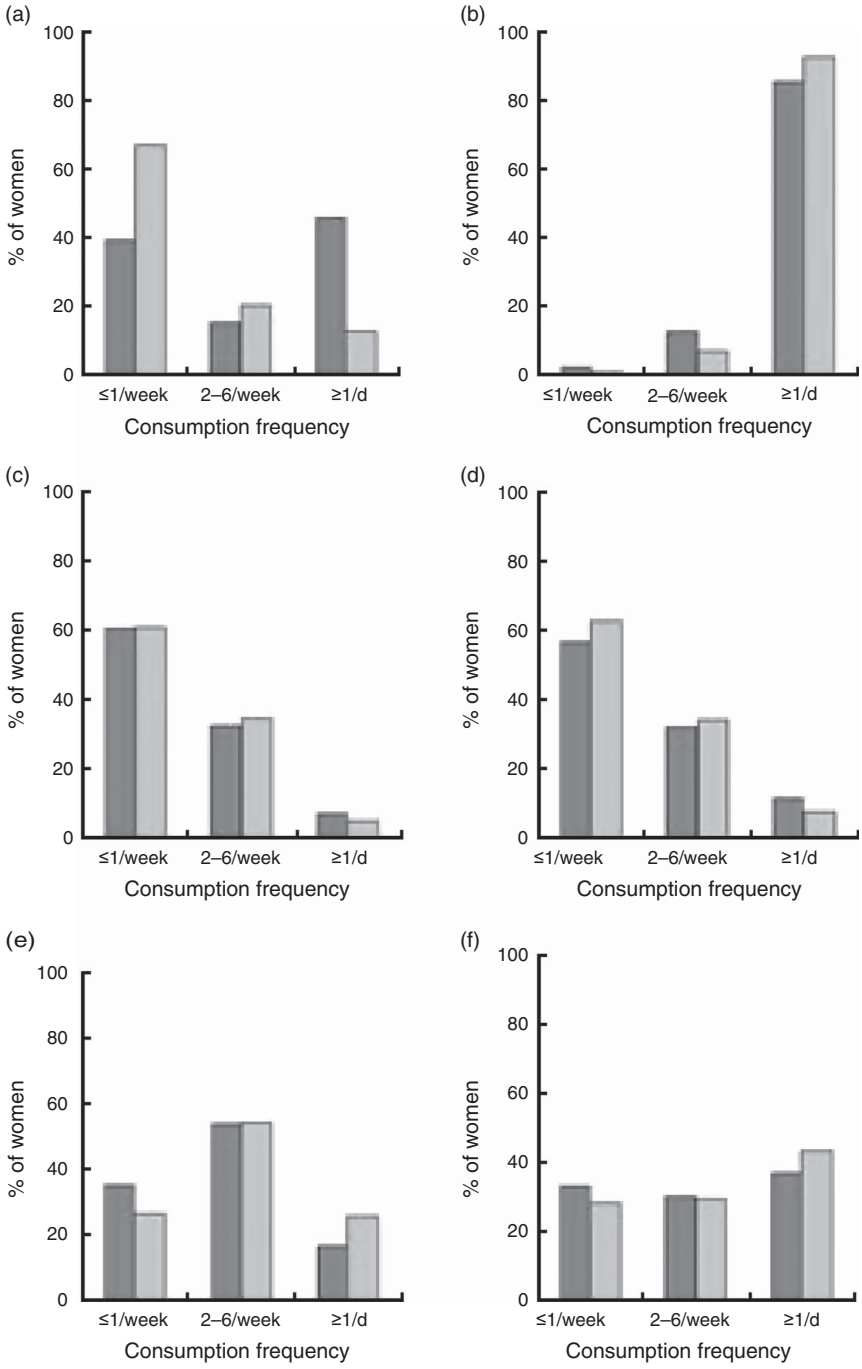

Fig. 2 Changes in the frequency of beverage consumption from pre-pregnancy (■) to early pregnancy (□) among 575 healthy, pregnant, nulliparous women participating in the Norwegian Fit for Delivery (FFD) trial: (a) coffee; (b) water; (c) sugar-sweetened beverages; (d) artificially sweetened beverages; (e) fruit juice; (f) milk

Inter-individual differences in type of beverage consumed and frequency of beverage consumption were large both pre-pregnancy and in early pregnancy. Water represented the most commonly reported beverage consumed at least daily both pre-pregnancy and in early pregnancy, followed by coffee, milk and fruit juice pre-pregnancy and by milk, fruit juice and coffee in early pregnancy. Low-fat milk (≤2 % fat)/extra low-fat milk (≤0·7 % fat) was the most commonly consumed milk.

Discussion

The present study revealed that, pre-pregnancy, 27 % of the women consumed alcohol at least once weekly and 15 % did not drink water daily. Furthermore, 10 % reported to drink SSB and 12 % to drink ASB at least once daily and only 37 % reported to drink milk at least once daily. In early pregnancy women changed their intake of different beverages. They stopped drinking alcohol and reduced

Table 2 Changes in frequencies of beverage consumption from pre-pregnancy to early pregnancy among healthy, pregnant, nulliparous women (*n* 575), Norwegian Fit for Delivery (FFD) trial, September 2009 to February 2013

	Pre-pregnancy		Early pregnancy*		
	%	95 % CI	%	95 % CI	*P* value
Coffee ≥ daily	38·4	33·4, 43·3	10·3	6·9, 13·7	< 0·001†
Low education	30·9	23·7, 38·1	9·1	4·1, 14·1	
High education	45·8	39·6, 52·1	11·6	7·2, 15·8	0·005‡
BMI < 25·0 kg/m^2	38·4	33·0, 43·8	13·0	9·3, 16·7	
BMI ≥ 25·0 kg/m^2	38·3	30·7, 45·9	7·7	2·4, 12·9	0·218‡
Age < 25years	29·2	21·0, 37·3	8·3	2·7, 13·9	
Age ≥ 25 years	47·6	42·0, 53·1	12·4	8·5, 16·2	0·003‡
Water ≥ daily	84·6	81·0, 88·2	91·5	88·8, 94·2	< 0·001†
Low education	84·6	79·3, 89·9	91·6	87·7, 95·6	
High education	84·6	80·0, 89·2	91·4	87·9, 94·8	0·925‡
BMI < 25·0 kg/m^2	85·9	81·9, 89·8	91·5	88·5, 94·4	
BMI ≥ 25·0 kg/m^2	83·3	77·7, 88·9	91·5	87·3, 95·7	0·344‡
Age < 25 years	84·4	78·4, 90·4	89·6	85·2, 94·1	
Age ≥ 25 years	84·8	80·7, 88·9	93·3	90·3, 96·4	0·282‡
SSB ≥ daily	9·9	7·3, 12·5	6·3	4·1, 8·5	0·001†
Low education	14·0	10·2, 17·8	9·8	6·6, 13·0	
High education	5·8	2·5, 9·1	2·9	0·1, 5·6	0·507‡
BMI < 25·0 kg/m^2	8·2	5·3, 11·0	5·4	3·0, 7·8	
BMI ≥ 25·0 kg/m^2	11·6	7·6, 15·6	7·2	3·9, 10·6	0·378‡
Age < 25 years	10·9	6·6, 15·1	5·8	2·3, 9·4	
Age ≥ 25 years	8·9	6·0, 11·8	6·8	4·3, 9·2	0·159‡
ASB ≥ daily	12·2	8·9, 15·4	9·0	6·2, 11·7	0·020†
Low education	14·7	10·0, 19·4	10·9	6·9, 14·9	
High education	9·6	5·5, 13·7	7·0	3·5, 10·5	0·645‡
BMI < 25·0 kg/m^2	7·4	3·9, 10·9	5·9	2·9, 8·9	
BMI ≥ 25·0 kg/m^2	16·9	11·9, 21·8	12·0	7·8, 16·3	0·172‡
Age < 25 years	7·3	2·0, 12·6	6·9	2·3, 11·4	
Age ≥ 25 years	17·0	13·4, 20·6	11·0	7·9, 14·1	0·045‡
Fruit juice ≥ daily	13·9	10·2, 17·7	20·1	15·8, 24·4	0·001†
Low education	11·8	6·4, 17·3	20·0	13·7, 26·3	
High education	16·0	11·3, 20·7	20·2	14·7, 25·7	0·226‡
BMI < 25·0 kg/m^2	13·2	9·1, 17·2	21·4	16·6, 26·1	
BMI ≥ 25·0 kg/m^2	14·7	9·0, 20·5	18·9	12·2, 25·5	0·196‡
Age < 25 years	11·1	5·0, 17·2	13·4	6·3, 20·5	
Age ≥ 25 years	16·8	12·6, 21·0	26·9	22·0, 31·7	0·029‡
Milk ≥ daily	36·7	31·8, 41·7	41·6	36·6, 46·7	0·015†
Low education	35·7	28·5, 42·9	40·1	32·7, 47·5	
High education	37·8	31·6, 44·0	43·2	36·8, 49·6	0·801‡
BMI < 25·0 kg/m^2	39·0	33·6, 44·0	41·9	36·3, 47·4	
BMI ≥ 25·0 kg/m^2	34·5	26·9, 42·1	41·4	33·6, 49·2	0·250‡
Age < 25 years	39·0	30·9, 47·1	39·8	31·5, 48·2	
Age ≥ 25 years	34·5	28·9, 40·0	43·4	37·7, 49·1	0·041‡

SSB; sugar-sweetened beverages; ASB; artificially sweetened beverages.
*Median gestational week 15 (range: 9–20).
†*P* value based on repeated measure model.
‡*P* value based on multilevel linear mixed model.

their consumption of coffee substantially. According to recommendations from Norwegian public health authorities, they did not replace these beverages with SSB or ASB. Instead there was a small, but significant decrease in the intake of both SSB and ASB. Moreover, the women reported a significant increase in their intake of water, fruit juice and milk from pre-pregnancy to early pregnancy.

Alcohol

A decrease in the consumption of alcohol from pre-pregnancy to early pregnancy has been reported across many populations[14,15,30,38], but not all studies have reported the same level of abstinence during pregnancy as the women in the present study[30,32,38]. The toxic effects of alcohol on the fetus have been known for more than 40 years[39] and consumption of alcohol during pregnancy is associated with congenital birth defects[23,40] as well as unfavourable developmental[20] and neurological outcomes[16]. The consequences of low to moderate alcohol consumption during pregnancy are somewhat contradictory, with some researchers reporting no effect on child behaviour or development[17,21] whereas others report significant negative effects[5]. Since there seems to be a considerable variation in how women and their fetuses metabolize alcohol, a precautionary approach advising pregnant women to abstain from alcohol is the best option[37]. The reduction in alcohol consumption from pre-pregnancy to early pregnancy clearly indicates that the women who took part in the

present study have understood and acknowledged the potential harmful fetal effects of alcohol in pregnancy. Current recommendations also tell women who plan to become pregnant not to consume alcohol[41,42]. In the present study only 11 % of the women were abstaining from alcohol at the time they got pregnant and 27 % consumed alcohol at least once weekly. Since most organogenesis happens in the early weeks of gestation before many women are aware of their pregnancy, there is a potential health benefit from increased adherence to national guidelines that advise women to abstain from alcohol when they are planning to get pregnant.

Coffee

The large and significant decrease in intake of coffee from pre-pregnancy to early pregnancy is a consistent finding in many studies[14,15,30,38]. Coffee consumption during pregnancy has been found to be associated with impaired fetal length growth[24], decreased birth weight[7] and increased risk of delivering a small-for-gestational-age infant[6,7]. Coffee consumption is relatively high in the Norwegian population. In the latest nationwide survey from 2011, average daily coffee intake was 270 ml among women aged 18–40 years, with the highest intake in the older age group[43]. In the present study women with higher educational attainment and older women were among the most frequent coffee drinkers. Both groups reduced their consumption frequency of coffee from pre-pregnancy to early pregnancy more than their younger and less educated counterparts. The reason for the decrease might be that women follow the clear and consistent advice from national health authorities. Additionally, the experience of nausea, altered beverage preferences and heartburn might have contributed to the reduction[14].

Water

The recommendation 'drink water when thirsty' is endorsed both for the general population and for pregnant women. In the present study, 15 % and 8 % did not drink water daily before pregnancy and in early pregnancy, respectively. There are several potential health benefits of the consumption of water. Overweight or obesity and excessive gestational weight gain are major concerns in antenatal care, and women with higher BMI have a larger risk of excessive gestational weight gain than normal-weight women[31]. Population studies have shown that replacement of SSB and fruit juice with plain water is associated with lower energy intake[44], lower weight gain[45] and lower risk of type 2 diabetes[46]. Furthermore, an intake of one to two glasses of water daily pre-pregnancy has been associated with a reduced risk of severe nausea and vomiting in pregnancy[47].

Sugar-sweetened beverages

The prevalence of both overweight and obesity has more than doubled among women of childbearing age in Norway between 1984/86 and 2006/08[48]. Changes in diet are one of the main causes of the obesity epidemic[49,50], and caloric beverages have increased their share of daily energy intake substantially during the last decades[51,52]. In addition, consumption of both carbonated and non-carbonated SSB is associated with elevated risk of pre-eclampsia[53] and preterm delivery[22]. SSB is not part of the daily diet for the majority of pregnant women in our study as only 10 % reported to drink SSB daily or several times daily pre-pregnancy. However, there is a concern that about one in two women with BMI $\geq 25{\cdot}0\ \mathrm{kg/m^2}$ reported drinking SSB more than once weekly both before and during pregnancy. Alcoholic beverages and coffee are part of socializing, and studies have shown that SSB might be used as a substitute for both alcohol and coffee[14]. The at least daily consumption of SSB among women in the present study is lower than the 19 % reported around gestational week 22 in the Norwegian Mother and Child Cohort Study (MoBa) conducted between 1999 and 2008[22]. Chen and co-workers also found a decrease in consumption of soft drinks from pre-pregnancy to pregnancy among Indian, Malay and Chinese women in Singapore[15], whereas Crozier and co-workers did not find any change in consumption of SSB from pre-pregnancy to early pregnancy in the Southampton Women's Survey which was conducted between 1998 and 2002[28]. Today pregnant women are specifically told not to drink SSB in excess, so awareness of the unhealthy aspects of SSB was probably higher when our study was conducted compared with 10–15 years ago.

Artificially sweetened beverages

High-quality epidemiological studies on the health effects of diet soft drinks are sparse. There is, however, a growing body of literature that suggests adverse health effects of ASB[54,55], and an association between daily intake of artificially sweetened soft drinks and increased risk of preterm delivery has recently been reported in two large population-based prospective studies[22,27]. Some researchers recommend that vulnerable subgroups, such as pregnant women, not to drink ASB[56]. The intake of ASB in the present study was much lower than reported in the MoBa cohort where 17 % the women reported daily intake of ASB in gestational week 22[22], compared with 8 % in the present study. The significant reduction in ASB consumption from pre-pregnancy to early pregnancy in the present study is reassuring. However, since pregnant women are regarded as a susceptible population for potential adverse effects of ASB, it is a concern that more than 40 % of the women in the present study consumed ASB more frequently than once weekly in early pregnancy.

Fruit juice

There was an increase in fruit juice consumption from pre-pregnancy to early pregnancy, highest among older women, and one in five women in the present study

consumed fruit juice at least daily in early pregnancy. Fruit juice might appear to be a healthy beverage given its content of vitamins, phytochemicals, minerals and antioxidants and has also been suggested as a popular replacement for coffee and alcohol during pregnancy[14]. Special taste preferences might be one reason why some women increase their consumption of juice when pregnant[14]. However, fruit juices are abundant in natural sugars and should therefore be consumed in moderation. Given the somewhat contradictory message from the Norwegian public health authorities where one glass of fruit juice is regarded as 'one fruit'[12], fruit juice might be perceived as not belonging to the 'sugary' beverages. Instead, fruit juices might be perceived as a healthy alternative to SSB and ASB and a beverage that does not need to be replaced by water despite the high sugar content. In an American study only 40 % identified fruit juice as 'sugary'[57]. Chen and co-workers reported that fruit juice consumption prior to pregnancy was not associated with gestational diabetes mellitus[58], and increased consumption of fruit juice during pregnancy has been found to be positively associated with a healthy diet[28,59,60]. On the other hand, large cohort studies have found positive associations between consumption of fruit juice and weight gain[26] and type 2 diabetes[61]. Thus, fruit juice might be regarded as a healthy beverage for women with a BMI within the normal range, but an unnecessary contributor of sugar and extra energy for women who are overweight or obese.

Milk

Milk is an important beverage in the traditional Norwegian diet, having a high concentration of nutrients such as protein, iodine, Ca, P, riboflavin and vitamin B_{12}. Research has shown a positive association between moderate maternal milk consumption during pregnancy and increased birth weight in a population of healthy Western women[62]. On the other hand, excessive intake of milk during pregnancy has been associated with an increased risk of large-for-gestational-age babies[19] and excessive maternal weight gain[31]. Only 42 % of the pregnant women in the present study met the Norwegian public health authorities' recommendation of consumption of one to two glasses of milk daily, and about one in three reported to drink milk once weekly at the most. In Norway, the consumption of milk has decreased in the last three decades and more so among women and the youngest adult age groups[52]. This is a concern because milk has been one of the main sources of iodine in the Norwegian diet and a recent study revealed that iodine intake is inadequate in a majority of pregnant Norwegian women[4]. Milk and milk products are main sources of saturated fat in the traditional Norwegian diet and for many years there has been a major public health focus on reducing intake of products such as fat cheese, cream and whole milk and increasing consumption of low-fat milk. One might speculate that many women associate milk with saturated fat and an unhealthy diet. Furthermore, a milk-free diet or diets with a minimal content of milk are advocated as part of many 'alternative' nutritional programmes.

In line with the Norwegian public health authorities' recommendation[12], the women in the present study mainly consumed low-fat milk and also reported a significant increase in consumption of milk from pre-pregnancy to early pregnancy. An increase in milk consumption from pre-pregnancy to pregnancy has also been found in other populations[15,30–32]. However, a British prospective study reported stable consumption of milk from pre-pregnancy to early pregnancy[28,38].

Early pregnancy is a time period where women are highly motivated to adopt a healthier lifestyle, including healthier beverage consumption habits. Thus, it is important to understand why some pregnant women demonstrate low adherence to diet recommendations. Our findings are consistent with other European studies of pregnant women which also showed that younger maternal age and lower educational attainment are predictors of an unhealthy dietary pattern[33,38,59,60,63]. The youngest age group and those with lower educational attainment appear to be particularly vulnerable groups who tend to make less appropriate lifestyle choices in pregnancy. Therefore they might require targeted advice to encourage compliance with public health recommendations.

Strengths and limitations

A major strength of the current study is that the women were recruited from antenatal clinics that most pregnant women in Norway attend as part of their routine pregnancy follow-up. Another strength is the high response rate. There is also evidence that data collected electronically are more valid than data collected by interviewer or paper questionnaire[64]. Since the participants had to answer each question to progress in the questionnaire, there were few missing data.

The study sample was confined to nulliparous women and was biased towards higher educated and older and younger women. In Norway in 2011, 48 % of women aged 25–29 years had not attended university[65], compared with 31 % in the present sample. The mean age at inclusion was 28·1 years and 25 % were aged < 25 years. The mean age of nulliparous women at delivery in Norway in 2011 was 27·7 years and 17 % were < 25 years[66]. One explanation for the high participation of pregnant women aged <25 years in the present study might be that Kristiansand is a university town.

By excluding mothers who did not speak Norwegian or English, the sample had few immigrant women. Previous research has shown that certain immigrant groups demonstrate unhealthy dietary patterns[67], whereas others have a healthier diet than the native population[33]. Other obvious limitations were the cross-sectional design, the

reliance on self-reported data and that the study did not investigate the full range of caffeinated beverages including tea, cola, energy drinks and cocoa. The FFQ used in the present study has shown acceptable test–retest reliability among pregnant women[68]. The FFQ challenges the respondents with complex tasks and in all dietary assessment methods misreporting is a serious problem[69]. Food items perceived as 'unhealthy' are under-reported to a larger degree than food and beverages perceived as 'healthy'[70,71]. This is especially relevant for the present study of beverages such as alcohol in particular, but also for coffee, SSB and ASB. The data on pre-pregnancy beverage consumption were collected in retrospect and thus we cannot rule out recall bias. Finally, the women who ended up participating in the FFD trial might have been more health-conscious and more likely to adhere to a healthy lifestyle than the average pregnant woman.

Women who are planning a pregnancy might already have made some changes in their diet. We did not specifically address this, but a qualitative study from The Netherlands showed that few women changed their diet prior to pregnancy[72]. Furthermore, it is well known that symptoms associated with pregnancy such as nausea, heartburn, increased appetite, cravings, aversions and tiredness make women change their beverage intake[29]. Since we did not monitor these symptoms, we do not know the reasons behind the observed changes in beverage consumption.

Conclusions and implications

Although we found a change towards healthier beverage consumption habits from pre-pregnancy to early pregnancy, potential health benefits with increased adherence to guidelines from the Norwegian public health authorities both pre-pregnancy and in early pregnancy remain. A proportion of women do not abstain from alcohol when planning to get pregnant and 15 % do not adhere to the advice 'drink water when thirsty'. Women who are overweight and obese may need advice on the importance of restricting beverages that are high in sugar content such as SSB and fruit juice. Our results suggest that more attention should be paid to the importance of milk in the maternal diet. Finally, given the recent findings on the increased risk of preterm birth with increasing consumption of ASB, a cautious attitude might be wise.

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