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Temporal changes in sugar-sweetened soft drink intake and variation across municipalities in the Capital Region of Denmark

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ABSTRACT

We aimed to examine the changes in sugar-sweetened soft drink intake across the Capital Region of Denmark from 2007 to 2013 and to examine the association between intake and neighbourhood socioeconomic status. The study included data from three health surveys in 2007 (n = 30,426), 2010 (n = 42,218) and 2013 (n = 34,330) in the Capital Region of Denmark. Frequency of soft drink intake was derived from questionnaires among residents aged 25–79 years and linked with information from central registers. Municipality social groups (MSG) 1–4 of decreasing affluence were defined as a composite measure. Logistic regression analyses were conducted for individuals with an appropriate soft drink intake (<once/week) and for individuals with a frequent soft drink intake (≥3 times/week). The proportion of individuals reporting an appropriate soft drink intake increased by 71% during 2007–2013 ($p < 0.0001$). A corresponding decrease was found in the proportion of individuals reporting a frequent soft drink intake. Compared to MSG 1, odds of an appropriate soft drink intake were significantly lower in MSG 3–4: OR = 0.87 (95%CI 0.83–0.91) and OR = 0.89 (95%CI 0.85–0.92), respectively. Compared to MSG 1, odds of a frequent soft drink intake were significantly higher in MSG 3–4: OR = 1.24 (95%CI 1.63–1.31) and 1.17 (95%CI 1.10–1.25), respectively. A significant interaction between MSG and educational level was found among individuals reporting a frequent soft drink intake ($p = 0.02$). The results show an encouraging reduction in frequency of soft drink intake among capital residents in the period of 2007–2013. A social gradient was observed in soft drink intake across MSG.

1. Background

To implement relevant public health strategies it is important to monitor the prevalence and temporal changes in specific risk behaviours for health and disease. Soft drink intake has been associated with an increased body weight and increased risk of chronic diseases such as type 2 diabetes (Vartanian et al., 2007). Putative underlying mechanisms include excess energy intake, incomplete compensation for liquid calories at subsequent meals and adverse glycaemic effects (Vartanian et al., 2007; Malik and Hu, 2015). The increasing knowledge of the detrimental effects of a high intake of soft drinks is reflected in the Danish dietary guidelines (Ministry of Environment and Food of Denmark, 2013).

Health related behaviours and chronic diseases are found to vary according to place of residence, and this variation is often explained by individual social differences such as educational level (Diderichsen et al., 2011; Mendis and Banerjee, 2010; Macintyre et al., 2002). However, factors within the local environment constrain individual level behaviours and choices, through mechanisms such availability (the structural environment) and normative attitudes towards health (the functional environment) (Leventhal and Brooks-Gunn, 2000; Jencks and Mayer, 1990; House JS et al., 1988; Sallis et al., 2006). Thus environmental factors are receiving increasing attention to assess their influence on health (World Health Organization, 2009; Lipek et al., 2015).

The social ecological models emphasize the nested arrangement of family, school, neighbourhood, and community context (Sallis et al., 2006). In light of these models, the composition of the environment i.e. the socioeconomic status (SES) and deprivation of a neighbourhood, can to some extend be viewed as a proxy for unmeasured structural and functional exposures. Deprived neighbourhoods are believed to have fewer health-promoting facilities and different social norms. Thus individuals residing within these areas are potentially exposed to substantially more unhealthy habits in their daily lives. This may have

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important implications for the initiation and maintenance of health behaviours e.g. soft drink intake, and the persistence of health inequalities across place of residence (Leventhal and Brooks-Gunn, 2000; World Health Organization, 2009).

Knowledge of soft drink intake in relation to the field of environmental exposures is limited. Pabayo et al. (Pabayo et al., 2012) found that a larger proportion of Canadian children regularly consumed soft drinks when living in low SES neighbourhoods in comparison to those living in higher SES neighbourhoods (Pabayo et al., 2012). Other studies indicates that low SES of a neighbourhood is associated with a frequent consumption of fast food and processed meals, a poorer nutritional status, less physical activity, and a higher prevalence of smoking and obesity (Igel and Grande, 2015; Turrell and Giskes, 2008; Thornton et al., 2009; Hanson and Chen, 2007; Pickett and Pearl, 2001). Yet, results are conflicting (Mozaffarian et al., 2012; Giskes et al., 2011; Fleischhacker et al., 2011; Feng et al., 2010). This is often explained by the heterogeneity in study designs and contextual differences that make it difficult to compare the impact of neighbourhood characteristics across states, countries, regions etc. Thus, neighbourhood SES could be an important determinant of soft drink intake among residents in the Danish population. Finally, associations between the environment and health behaviours may be modified by individual factors (Jencks and Mayer, 1990; World Health Organization, 2009; Feng et al., 2010).

Attention to the prevalence of exposures and relative risks can ensure that preventive efforts and public health policy will focus on those population sub-groups and geographical areas where most benefit can be expected. Therefore this study aimed to examine the changes in soft drink intake in the Capital Region of Denmark from 2007 to 2013. Furthermore, we aimed to examine the association between intake of soft drinks and municipality deprivation, and whether this association is modified by individual educational level.

2. Methods

2.1. The Danish capital region health survey

The present study is based on data from three cross-sectional health surveys conducted in the 29 municipalities of the Capital Region of Denmark in 2007, 2010 and 2013 (Glümer et al., 2008; Hammer-Helmich et al., 2011; Robinson et al., 2014). The surveys were conducted in September in 2007 and from February to April in 2010 and 2013. A random sample of individuals in each municipality was drawn from the Danish Civil Registration System (CRS) (Pedersen et al., 2006). This register identifies all inhabitants in Denmark by a unique 10-digit personal identification number (CPR), which allows record linkage on an individual level to data from complete national registers on e.g. education and income.

The total sample included 69.800 individuals in 2007 and 95,150 individuals in both 2010 and 2013 (Fig. 1). In all three survey years the municipality of Copenhagen was divided into ten areas according to the official administrative districts, and these were treated as individual municipalities in the sampling process resulting in a total of 38 municipalities. In 2007 1800 persons aged 25 years or older were sampled from each municipality. Due to differences in population size between municipalities the sample size in Frederiksberg Municipality was increased to 3000 persons. In 2010 and 2013 2450 persons aged 16 years or older were sampled from each municipality and the sample size in Frederiksberg Municipality was 4500 persons.

Each individual received a mailed invitation and a paper questionnaire (a web-based version was also available in 2010 and 2013). The questionnaire contained questions on health behaviour. The response rate was 52.3% (N = 36,472) in 2007, 52.3% (N = 49,806) in 2010 and 43.5% (N = 41,356) in 2013 (Fig. 1). Among those who did not respond to the questionnaire a higher proportion was men, unemployed, had a short educational, had a low gross income, and was of another ethnicity than Danish, for all three survey years (Glümer et al., 2008; Hammer-Helmich et al., 2011; Robinson et al., 2014).

2.2. Soft drink intake

Frequency of sugar-sweetened soft drink intake (carbonated or non-carbonated) was assessed from the survey questionnaires. Questions were based on a validated 48-item food frequency questionnaire (Toft et al., 2015). Participants were asked the following question: "How often do you drink sugar-sweetened soft drinks?", with six possible responses (rarely or never, 1–3 times/month, 1–2 times/week, 3–4 times/week, 5–7 times/week, and more than once/day). This categorization allowed us to examine associations among individuals who *assumingly* have an appropriate soft drink intake according to the Danish Dietary Guidelines (max of ½ L/week) and those who have a frequent soft drink intake. Appropriate soft drink intake was defined as 1) soft drink

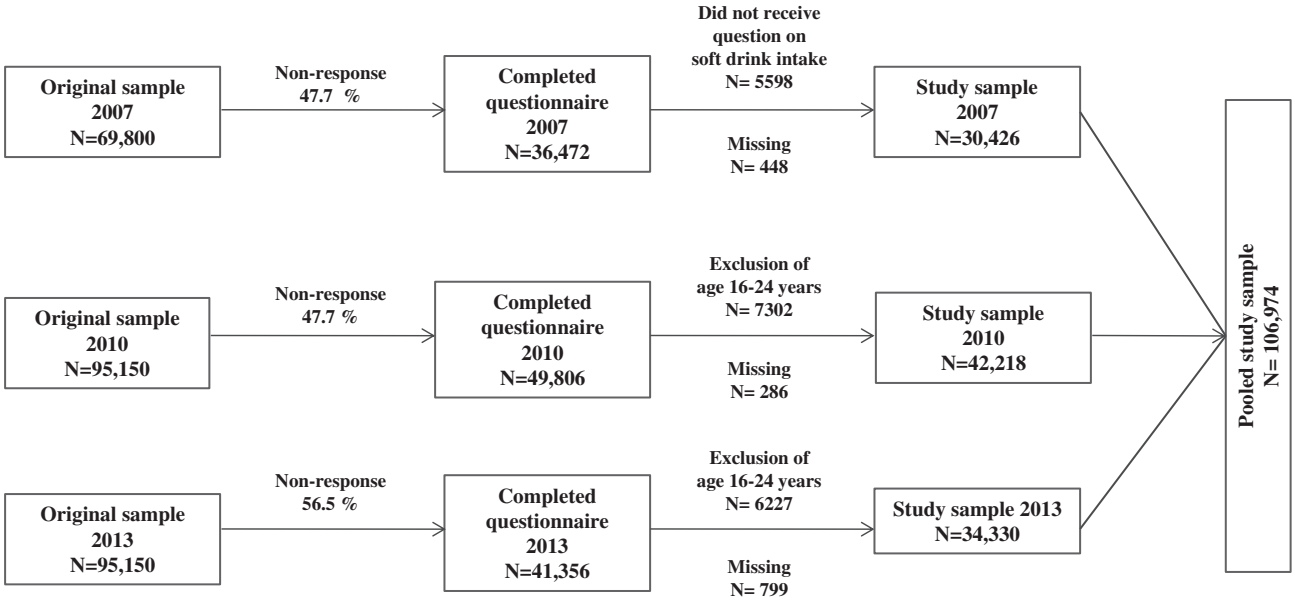

Fig. 1. Flowchart of three health surveys in the Capital region of Denmark in 2007, 2010 and 2013.

intake < once per week, and a frequent soft drink intake was defined as 2) soft drink intake ≥3 times per week.

In 2007 five municipalities (Gladsaxe, Herlev, Hoeje-Taastrup, Hoersholm and Vallensbaek) did not receive the question on soft drink intake, thus these were excluded from the statistical analysis this year (Fig. 1).

2.3. Municipality social groups

Neighbourhood SES of the 38 municipalities was described through a composite measure combining the distribution of the educational level, employment status and mean gross income of the residents. Information was derived from central registers i.e. the Danish Population's Education Register (PER), the Employment Classification Module (AKM) and the Income Statistics Register (Jensen and Rasmussen, 2011; Petersson et al., 2011; Baadsgaard and Quitzau, 2011). This resulted in four municipality social groups (MSG) of decreasing affluence (Appendix 1). MSG 1 included the most affluent municipalities while MSG 4 included the most deprived municipalities.

2.4. Individual level covariates

The covariates included survey year, gender, age and educational level. Information on age and gender was obtained from the CRS (Pedersen et al., 2006), while data on educational level (highest completed education) were drawn from the PER (Jensen and Rasmussen, 2011) and linked with questionnaire data on soft drink intake using CPR numbers. Educational level was categorised into four groups: "Primary or secondary school", "Vocational education", "Academy or bachelor degree" and "Master or PhD degree". Educational level was used as an indicator for individual socioeconomic position since there is considerable evidence demonstrating that an individual's educational status is an important predictor of dietary patterns (Groth et al., 2014).

2.5. Statistical analyses

Since the survey in 2007 only included individuals aged 25–79 years, the data from 2010 and 2013 were limited to this age group in order to achieve a comparable study population for the regression analyses (Fig. 1).

Descriptive analyses were performed using chi square statistics. Data from the three surveys were pooled leaving a total of 106.974 individuals for the statistical analyses performed using survey procedures in SAS statistical software (version 9.3, SAS Institute Inc., Cary, NC, USA).

The crude association between soft drink intake (appropriate or frequent) and MSG was investigated using logistic regression and the analyses were further adjusted for survey year, gender, age and educational level. Further, an interaction term between survey year and MSG was included and interactions between MSG and educational level were tested. Odds Ratios (ORs) with 95% confidence intervals (CIs) indicated the likelihood of an appropriate or frequent soft drink intake relative to the reference group.

We know from previous research within the same population that non-response differs by socio-demographic characteristics and cause-specific morbidity and mortality (Christensen et al., 2015; Christensen et al., 2014). Thus, all analyses were weighted to account for the stratified non-response and further to account for sampling design. The weights were computed by Statistics Denmark based on information about gender, age, municipality, educational attainment, income, civil status and hospitalization (Christensen et al., 2012).

3. Results

A total of 106,974 participants were included for analyses and a total of 75.217 respondents (62.9%) reported an appropriate weekly soft drink intake (Table 1). Among these, a higher proportion was women, of higher age, or had a long educational level. A total of 15.690 respondents (16.3%) reported a frequent soft drink intake. Among these a higher proportion was men, of younger age, or had a short educational level.

Table 1
Characteristics of the study population in the Capital Region of Denmark. Total number of respondents = 106,974

Soft drink intake	<1 time per week (appropriate intake)		1–2 times per week		≥3 times per week (frequent intake)	
	%[a]	Respondents	%[a]	Respondents	%[a]	Respondents
Respondents	62.9	75,217	15.9	16,067	16.3	15,690
Gender[b,c]						
Women	70.6	45,853	13.0	7454	11.5	6317
Men	54.9	29,364	18.8	8613	21.2	9373
Age[b,c]						
25–34 years	48.4	8076	23.3	3771	23.9	3863
35–44 years	55.4	12,407	20.1	4487	19.5	4096
45–54 years	64.5	15,667	15.6	3585	15.1	3181
55–64 years	74.6	18,868	9.7	2356	10.4	2277
65–79 years	77.0	20,199	7.5	1868	9.7	2273
Education[b,c]						
Primary or secondary school	59.1	16,422	15.1	3584	19.6	4401
Vocational education	60.5	24,310	15.4	5310	18.6	6062
Academy or bachelor degree	66.8	21,358	16.5	4336	12.7	3251
Master or PhD degree	68.9	11,819	17.0	2510	10.0	1599
Survey year[b,c]						
2007	49.7	18,226	17.2	5649	21.3	6551
2010	68.2	30,684	15.7	5987	15.4	5547
2013	70.2	26,307	14.8	4431	12.3	3592
Municipality social group[b,c]						
Municipality social group 1	68.6	20,396	14.5	3785	13.1	3221
Municipality social group 2	63.6	21,323	15.5	4462	14.7	4076
Municipality social group 3	60.7	16,685	16.2	3774	19.7	4168
Municipality social group 4	19.2	16,813	17.1	4046	18.9	4225

[a] Weighted for non-response and survey design.
[b] The sum does not add up to the total due to missing values.
[c] Chi^2 test $p < 0.0001$.

The proportion of individuals reporting an appropriate weekly soft drink intake increased by 18.8% point between 2007 and 2010 ($p < 0.0001$) and further by 2% point between 2010 and 2013 ($p < 0.0001$), corresponding to a 71% increase during 2007–2013 (Table I). Correspondingly the proportion of individuals reporting frequent weekly soft drink intake decreased between 2007 and 2010 and further between 2010 and 2013 by 5.9% point and 3.1% point, respectively ($p < 0.0001$). This corresponded to a 58% reduction during 2007–2013.

3.1. Associations for an appropriate soft drink intake

Crude OR and 95%CI of having an appropriate soft drink intake compared to MSG 1 was 0.83 (0.83–0.87), 0.69 (0.66–0.72) and 0.66 (0.63–0.67) for MSG 2, 3 and 4 respectively (Table 2). The association attenuated when the model was adjusted for age, gender and educational level, but remained significant; 0.98 (0.94–1.03), 0.87 (0.83–0.91) and 0.89 (0.85–0.92). No interaction was found between survey year and MSG in neither the crude ($p = 0.62$) nor the adjusted models ($p = 0.34$). We found no significant interaction between MSG and individual educational level in the adjusted model ($p = 0.09$).

Table 2
The association between a soft drink intake and municipality social group in the Capital Region of Denmark.

Municipality social group[b]	<1 time per week (appropriate intake)		≥3 times per week (frequent intake)	
	Crude OR (95%CI)	Adjusted OR (95% CI)[a]	Crude OR (95%CI)	Adjusted OR (95% CI)[a]
1	1	1	1	1
2	0.83 (0.83–0.87)	0.98 (0.94–1.03)	1.20 (1.13–1.27)	1.04 (0.98–1.10)
3	0.69 (0.66–0.72)	0.87 (0.83–0.91)	1.57 (1.48–1.66)	1.24 (1.16–1.31)
4	0.66 (0.63–0.67)	0.89 (0.85–0.92)	1.55 (1.46–1.65)	1.17 (1.10–1.25)

Data shown are crude and adjusted Odds Ratios (OR) with 95% Confidence intervals.
[a] Adjusted for age, gender, educational attainment and survey year.
[b] Type 3 analysis of effects was significant with $p < 0.0001$ for both crude and adjusted models.

3.2. Associations for a frequent soft drink intake

Crude OR and 95%CI of having a frequent soft drink intake compared to MSG 1 was 1.20 (1.13–1.27), 1.57 (1.48–1.66) and 1.55 (1.46–1.65) for MSG 2, 3 and 4 respectively (Table 2). The association attenuated when adjusted for age, gender and educational level, but remained significant; 1.04 (0.98–1.10), 1.24 (1.16–1.31) and 1.17 (1.10–1.25). No interaction was found between survey year and MSG in neither the crude ($p = 0.91$) nor the adjusted models ($p = 0.92$). We found a significant interaction between MSG and individual educational level ($p = 0.02$) in the adjusted model. Individuals with an educational level corresponding to primary or secondary school residing in MSG 1 (affluent municipalities) have significantly lower odds of a frequent soft drink intake compared to residents from MSG 4 (most deprived municipalities) within the corresponding educational level (Fig. 2). We found no significant difference in the frequency of soft drink intake across MSG among individuals with a Master or PhD degree.

Exclusion of the five previously mentioned municipalities from all three survey years neither altered the prevalence of respondents reporting drinking soft drink intake nor the conclusion of the analyses (Results not shown).

4. Discussion

In this study we found overall improved soft drink habits among residents in the Capital Region of Denmark in the period of 2007–2013. That is, across time less individuals report a frequent intake of sugar-sweetened soft drinks and more individuals report an appropriate intake. A social gradient in soft drink habits was observed across MSG implying a compositional impact of neighbourhood SES. Thus, soft drink intake was more frequent among residents in deprived municipalities compared to residents in affluent municipalities after adjusting for individual characteristics. Correspondingly, an appropriate soft drink intake was more frequent among residents in affluent municipalities. These associations were not modified by survey year. Among individuals with an appropriate soft drink intake we found no indication of a social gradient across MSG for individuals with the same educational level, however a social gradient was observed across MSG among individuals with a frequent soft drink intake within the same educational level. That is, a frequent soft drink intake was more prevalent among individuals with a short educational level (i.e. primary or secondary school and vocational education) residing in deprived municipalities compared to individuals with a short educational level residing in the least deprived municipalities. No trend was seen among residents with a Master or PhD degree.

From a public health perspective our findings of improved soft drink habits are encouraging. To our knowledge, this is the first study on time trends in soft drink intake within this period among an adult population; however time trends in the present study are in line with national trends (Statistics Denmark, 2015; Statistics Denmark and The Danish Brewers' Association, 2014; Pedersen et al., 2015). The national Household Budget Survey shows a 20% decrease in money spent on soft drinks from 2007 to 2013 when adjusting for price changes (Statistics Denmark, 2015). Furthermore the Danish Brewer's Association and Statistics Denmark show a 11% decrease in litres of soft drink consumed per capita from 2007 to 2013, with the steepest decline from 2007 to 2010, as is found in the present study. The improved soft drink habits found in the present study does not seem to be due to a replacement of sweetened soft drinks by sugar-free alternatives. Statistics Denmark finds no corresponding increase in the consumption of non-sugar-sweetened soft drinks; a 4% decrease from 2007 to 2010 and no changes from 2010 to 2013 (Statistics Denmark and The Danish Brewers' Association, 2014). Unfortunately information on this subject was only available in the present survey data from 2010 and 2013. However, within this period intake of non-sugar-sweetened soft drinks 3 times or more per week did not differ significantly when adjusting for survey year, gender, age and education (Results not shown). In 2012, taxes on soft drinks and chocolate were extended. Thus, the time trend found on soft drink

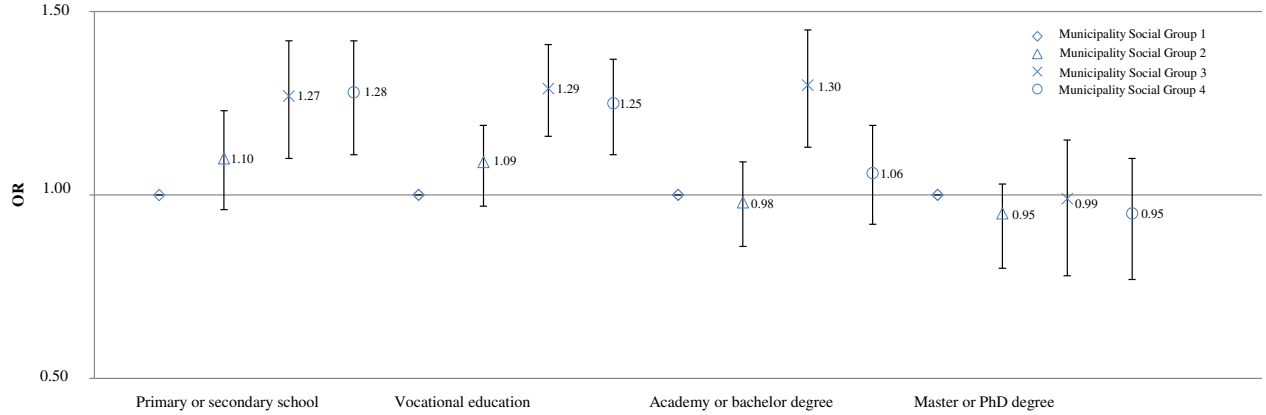

Fig. 2. The association between a frequent soft drink intake (≥3 times/week) and educational level across municipality social class in the Capital Region of Denmark. Data are shown as Odds Ratios (OR) with 95% Confidence intervals, adjusted for age, gender, educational attainment and survey year.

habits in the present study may be explained by an increased public attention facing the governmental initiatives targeting people's food and drinking habits (Stafford, 2012).

To our knowledge this study is the first to investigate the association between soft drink habits and the neighbourhood SES in an adult population. We found an impact of neighbourhood SES which is in line with previous studies on area SES in relation to health behaviours and diseases (World Health Organization, 2009; Pickett and Pearl, 2001). Vereecken et al. (2005) investigated the influence of two area SES measures on soft drink intake among adolescents in Europe (Vereecken et al., 2005). Area SES at country level was defined by family material wealth while area SES at school level was defined by family affluence and/or parental occupation status. A social gradient in the daily soft drink intake was found at school level in the Northern, Southern and Western European countries. That is, the proportion of pupils with a daily soft drink intake was lower among pupils of higher parental occupation status.

In addition to the impact of neighbourhood SES on soft drink intake we found an impact of individual-level SES; individuals with a frequent soft drink intake within the same MSG were affected differently depending on their educational level. This suggests that the intake of soft drinks among individuals with a frequent intake and a short educational level may be influenced by neighbourhood factors such as norms, culture and accessibility, while intake of soft drinks among individuals with a long educational level may be more likely to be influenced by individual factors. Considering the wide CI's within these groups, the lack of trend among residents with a Master or PhD degree could be due to lack of strength in data within these groups. However, this finding is in accordance with the literature in which it is increasingly accepted that interventions focusing on environmental factors have a differential effect, i.e. a greater impact on the most exposed individuals, e.g. the less educated, while individual-based interventions has the opposite pattern, having a greater impact among the less exposed individuals, e.g. the most educated (Diderichsen et al., 2011; Feng et al., 2010).

Major strengths of the present study include the large representative sample of residents in the Capital Region of Denmark with different socioeconomic characteristics. Complete information on the SES of the participant's residential neighbourhood as well as the individual covariates where provided by good quality registers in Denmark (Pedersen et al., 2006; Jensen and Rasmussen, 2011; Petersson et al., 2011; Baadsgaard and Quitzau, 2011). Furthermore, all analyses were weighted to account for the differing in non-response by socio-demographic characteristics and cause-specific morbidity and mortality.

We acknowledge that our study has some methodological limitations. First, the outcome is based on self-report and therefore recall and reporting bias may exist. Underreporting of unhealthy eating habits is common among obese and individuals with a high SES as these groups are more likely to be conscious of social desirable eating habits (Heitmann and Lissner, 1995; Johansson et al., 2001; Ball et al., 2006). Thus, assessment of time trends is potentially influenced by the increasing attention towards health, and estimates found in the present study are thus conservative and the true association potentially stronger. That the estimates would be conservative is supported by the fact that the proportion of individuals reporting a frequent soft drink intake are highest among the same population sub-groups that do not respond to questionnaires (e.g. men, young, short educational level). Second, it should be emphasized that the three surveys were conducted in different time periods (September and February–April) using questionnaires only assessing the frequency of consumption and not the amount. Thus it is plausible that the reported soft drink intake is biased by a seasonal effect and further, that the results are influenced by changing portion – and bottle sizes over time. National time trends show largest sales and purchases of soft drinks during July–September (Statistics Denmark, 2016) hence this may to some extend explain the decrease found in the reported soft drink intake from 2007 to 2010; however, as mentioned earlier, present results are in line with national time trends on consumption (Statistics Denmark, 2015; Statistics Denmark and The Danish Brewers' Association, 2014; Pedersen et al., 2015). Third, the exclusion of participants below 24 years of age in 2007 may be a limitation since soft drink intake decreases with age (Glümer et al., 2008; Hammer-Helmich et al., 2011; Robinson et al., 2014). Even so, conducting similar analyses on 2013 data alone did not yield markedly different results (results not shown). Fourth, the geographical boundaries imposed to define neighbourhoods in the present study are based on pre-determined administrative units (municipalities) and may not correspond with the boundaries that shape the relevant environment for soft drink intake. Additionally, the municipalities comprise a large geographical area in which the individual SES may vary widely. Fourth, there are potential problems in using information on educational level both as an individual variable and as a part of a composite measure; however this is fairly unproblematic due to their weak correlation. Further, information on the highest level of achieved education was drawn from central registers and applied to calculate the prevalence of individuals with a short educational level for each municipality (Appendix 1). Thus MSG comprise data on educational level from all citizens (with a short educational level) within each municipality and not solely data from participants of the study as is the case for the individual variable of educational level. Finally, the present data is based on cross sectional surveys from which it is not possible to determine whether the associations observed are causal. Similarly, we are not able to determine the direction of the association. Selective population movements may have imitated the compositional impact of neighbourhood SES on soft drink intake found in the present study. Hence, people with similar characteristics, behaviours and perceptions may choose, or be forced to reside in a given neighbourhood which consequently would cause inferences on the direction of the found associations. The fact that the association was not modified by survey year, do however establish a temporal sequence between neighbourhood SES and soft drink intake, thus suggesting that deprived neighbourhoods in the Capital region of Denmark are disadvantaged in regards to soft drink habits, and potentially other health behaviours.

5. Conclusion

The results of the present study showed an encouraging reduction in unhealthy soft drink habits among capital residents in the period of 2007–2013. The social gradient observed in sugar-sweetened soft drink intake across MSG was not modified by individual educational level among individuals with an appropriate soft drink intake; however this was the case among individuals reporting a frequent weekly soft drink intake.

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.pmedr.2016.08.005.

Ethics

The research project was approved by the Danish Data Protection Agency according to the Danish Act on Processing of Personal Data. Approval from the Danish Health Research Ethics Committee System was not required according to Danish law, as the research project was purely based on data from questionnaires and national registers. Written informed consent for publication based on the questionnaire data was given by the participants when returning the questionnaires.

Declaration of conflicting interests

The authors declare that there are no conflicts of interest.

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Transparency document

The Transparency document associated with this article can be found, in the online version.

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