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2015

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Published on

Public Health Nutrition 18(15), 2825–2835

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Abstract

Objective: To explain patterns of fruit and vegetable consumption in 9 former Soviet Union (fSU) countries by exploring the influence of a range of individual and community level determinants

Design: Cross-sectional nationally representative surveys and area profiles were undertaken in 2010 in nine countries of the fSU as part of the Health in Times of Transition (HITT) study. Individual and area-level determinants are analyzed, taking into account potential confounding at the individual and area level.

Setting: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Ukraine

Subjects: 17,998 adult survey respondents aged 18-95

Results: Being male, increasing age, lack of education and lack of financial resources are associated with lower probability of consuming adequate amounts of fruit or vegetables. Daily fruit or vegetable consumption is positively correlated with the number of shops selling fruit and vegetables (for women), and with the number of convenience stores (for men). Billboard advertising of snack and sweet drinks is negatively related to daily fruit or vegetable consumption, although the reverse is true for billboards advertising soft drinks. Men living near a fast food outlet have a lower probability of fruit or vegetable consumption, while the opposite is true for the number of local food restaurants.

Conclusions: Overall fruit and vegetable consumption in the fSU is inadequate, particularly among lower socioeconomic groups. Both individual and community-level factors play a role in explaining inadequate nutrition and thus provide potential entry points for policy interventions, while the nuanced influence of community factors informs the agenda for future research.

Keywords: nutrition, fruit and vegetable consumption, socioeconomic determinants

Introduction

The publication of the 2010 Global Burden of Disease study reinforced the importance of adequate fruit and vegetable consumption [1], primarily via its impact on cardiovascular health [2] and some cancers [3; 4]. The World Health Organization (WHO) and the Food and Agricultural Organization (FAO) recommend a minimum fruit and vegetable consumption of at least 400 grams a day per adult [5].

The volume of research on determinants of fruit and vegetable consumption in high income countries [6; 7; 8] is not matched by its scarcity in the countries of the former Soviet Union (fSU), even though global agricultural trade data suggest that consumption there is especially low [4]. One survey found fruit and vegetable consumption to be inadequate (defined as eating <400g, or 5 servings of 80 grams a day) among 80% of people in Russia, 92% in Kazakhstan, and 55%, in Ukraine [9]. Another study found that 93% of men living in Russian Karelia consumed inadequate vitamin C, compared with only 2% in neighbouring Finnish Karelia [10], subsequently linked to low fruit consumption [11].

Although studies of environmental determinants of dietary consumption have increased globally, the existing evidence remains insufficient to draw robust conclusions [12], and what does exist is limited in scope. Brug [13] contrasts the relative lack of evidence on macro-level environmental determinants of nutrition with that on micro-level determinants, and most research world-wide has focussed on biological, psychological, behavioural, and social factors acting at the individual level [13]. However, there is growing interest in the role of environmental determinants [14; 15], as the explanatory power of individual factors alone has proved limited [16].

By assessing both individual (e.g. age, gender, marital and socioeconomic status) and community-level (e.g., advertising for high calorie food and drinks, availability of shops selling fruit and vegetables, ease of access to fast food outlets) drivers of fruit and vegetable consumption in nine fSU countries, this study contributes to the global body of research on determinants of diet and obesity. Our aims are, first, to present new estimates of the prevalence of fruit and vegetable consumption in nine fSU countries and, second, to identify relevant individual- and community-level determinants.

Methods

Study design

Data are from household surveys in nine countries of the fSU as part of the Health in Times of Transition (HITT) study [17]. This used the same standardized questionnaire in each country to capture a range of health outcomes, health-behaviors, and demographic, socio-economic and environmental characteristics. Surveys were nationally representative and conducted among adult respondents (aged ≥ 18 years) in Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, and Ukraine.

Multi-stage random sampling with stratification by region and rural/urban settlement type was applied. Sample size for the urban and rural population was determined proportionally to these populations in each study country. Primary sampling units (PSUs) were selected randomly using the Probability Proportional to Size (PPS) technique from routine data. Within each PSU - about 100–200 per country, except Russia and Ukraine with 329 and 435 PSUs respectively - households were selected by random route procedures. Within each selected households one person was chosen (based on nearest birthday). If after 3 visits (on different days and times) there was no one at home, the next household on the route was selected.

The surveys were conducted between March and May 2010, except in Kyrgyzstan where there was a delay until March to May 2011 due to political violence. Face-to-face interviews were conducted by trained fieldworkers in respondents' homes. Response rates varied from 47.3% in Kazakhstan to 83% in Moldova. Each country had 1800 respondents, except Russia (N=3000) and Ukraine (N=2200) to reflect their larger and more regionally diverse populations, and Georgia (N=2200) where a booster survey of 400 additional interviews was undertaken in November 2010 to ensure a more representative sample. The final sample used in the individual-level regression analysis was slightly smaller due to a small number of missing observations. The sample that was used in the community-level analysis was considerably smaller due to the fact that only a subsample of communities was selected for data collection. However, since the communities were randomly drawn from the larger number of sampling units used in the main HITT household survey, there is unlikely to be any bias introduced by this drop in the sample size (as the individual observations are also missing at random).

The draft questionnaire was forward and backward translated into each of the languages in which it was administered, and then piloted with approximately 15 people in each country. Except in Russia and Belarus (where all interviews were conducted in Russian), respondents were given the choice of answering in Russian or a national language.

The research was approved by the ethics committee of the London School of Hygiene and Tropical Medicine and was conducted in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki. All persons gave informed consent. Quality control procedures included re-interviews to assess the work of both the interviewers and the interviewers' supervisors.

Variables

Our main dependent variable is daily or almost daily consumption of fruit or vegetables (excluding potatoes). This ranges from 1-referring to daily or almost daily consumption, to 4-referring to consuming fruit or vegetables less than once a week, (with only information on the frequency of consumption being available, and not on the quantity).

Our independent variables include indicators for people who believe that good diet is unimportant, age, being female, having primary or secondary levels of education as the highest attainment, reporting good economic status, number of people in the household, being married, asset classes, and living in the rural area. More details are given in the Annex.

Additional community-level variables were recorded in a sub-sample of 333 PSUs randomly selected from those in the main household surveys. The community-level variables were measured using a standardized Community Observation Form, based upon the validated Prospective Urban and Rural Epidemiology Study's Environmental Profile of a Community's Health (EPOCH) instrument [(18)]. Two trained data collectors per community systematically recorded aspects of the environment relating to general social/economic situation (e.g. community specific architecture such as conditions of homes and roads), nutrition and physical activity (e.g. walkability and food environment), and tobacco and alcohol (e.g. availability and advertising). Thirty community profiles were conducted in each country, except Russia (73 profiles) and Ukraine (50 profiles) to reflect their larger and more regionally diverse populations. Additional information on community profile instrument is available elsewhere [(19)].

We use data on the number of outdoor advertisements (e.g. billboards, adverts on shop windows, bus shelters and other easily accessible locations) for fast food, for snacks, for fizzy carbonated drinks, as well as for sweet drinks (including juices). These were collected independently of the interviews.

Community-level data also include the number of shops/other outlets selling sweets, biscuits and crisps, as well as fruit and vegetables, with kiosks being included in this

category. Incidentally, in the fSU kiosks rarely appear to sell fruit and vegetables and instead appear primarily as outlets for alcohol and tobacco[20]. Finally, information was obtained on whether people live within an "easy walk" from fast food outlets within a community, as well as on the number of restaurants and cafes in the community selling local food. Cafeterias were counted separately from fast-food restaurants.

All variables used in the analysis are based on closed-ended questions, except the information on the number of advertisements/outlets, collected by two observers per community.

Statistical analysis

We examine the statistical association between fruit and vegetable consumption and potential individual and community-level determinants. Analysis is conducted using Stata 11. We start the analysis with the ordinary least squares regression, where the outcome variable is daily, or almost daily consumption of either fruit, *or* vegetables, which is regressed on individual-level covariates and country dummies. We then control for potential confounding with community fixed effects (CFE).

Next, as our interest shifts to estimating the association between several community-level variables and fruit or vegetable consumption, we regress this outcome on the set of community-level covariates of interest, as described below. To reduce the potential for confounding, we control for several potentially relevant community-level variables, as well as for regional fixed effects.

Finally, to take advantage of the ordered nature of the underlying variables used to define consumption, ordered probit results are estimated, separately for fruit and vegetable consumption. As the underlying outcome variable ranges from 1 to 4, with the value of 1 referring to eating fruit or vegetables less than once a week, and 4- to eating daily or almost daily, positive ordered probit estimates indicate a greater probability of eating fruit or vegetables and, conversely, negative estimates are associated with factors that reduce the likelihood of consuming fruit and vegetables. Although, in principle, one may apply multinomial logit or probit models to estimate effect of covariates on these outcomes, ordered probit specification takes advantage of the natural ordering of the data, also allowing a more parsimonious presentation of results [21].

The initial specification is as follows:

$$Y_{isc} = \alpha_0 + \alpha_1 Z_{isc} + \eta_c + e_{isc} \quad (1)$$

Here, Y is the dummy variable for individual *i* living in community s located in country *c*, with the value of 1 assigned to individuals reporting daily, or almost daily consumption of either fruit, *or* vegetables. In equation (1), the main interest is in the parameters contained in a vector α_1, obtained from regression of the outcome variable Y_{isc} on the vector of individual-level determinants Z_{isc} and country effects η_c, as described in the measures section.

To control for additional area-level confounders that affect both the covariates of interest included in Z_{isc}, and the outcome variable, a richer specification is considered that replaces country with community fixed effects. For example, community-level infrastructure and employment opportunities may be a determinant of both fruit and vegetable consumption, as well as of reporting good health and of good economic status. Also, to control for any correlation of the error term e_{isc} among individuals belonging to the same community, we cluster standard errors on the community level.

Next, the association of community-level determinants with the same outcome of interest is estimated according to following specification:

$$Y_{isc} = \alpha_0 + \alpha_1 X_{sc} + \alpha_2 Z_{isc} + \alpha_3 S_{sc} + \mu_{rc} + e_{isc} \quad (2)$$

The parameters contained in vector α_1 are associated with a vector of community determinants (also used as simultaneous controls) $X_{sc} = [X^1_{sc}, X^2_{sc}, X^3_{sc}]$ that includes three sets of community determinants:

1) X^1_{sc} includes variables measuring exposure to different types of advertising for high calorie food and drink. As an ad-hoc hypothesis, it is expected that greater exposure to these advertisements will negatively affect the probability of daily fruits and vegetables consumption.

2) With X^2_{sc}, the focus is on availability of healthy and unhealthy foods in stores. *A priori*, one expects fruit and vegetable outlets to increase availability of those products, as well as positively affect preferences for their greater consumption, while the reverse will be true for stores selling sweets and crisps.

3) Finally, in X_{sc}^{3}, the focus is on outside eating establishments, such as ease of access to fast food and general service restaurants. Our *a priori* expectation is that easier access to fast food outlets will be associated with worse dietary attitudes and lower fruit and vegetable consumption; at the same time it is not clear what association to expect between our outcomes of interest and numbers of local restaurants.

The main problem with estimating specification (2) is potential area-level confounding. For example, some previous research found fruit and vegetable consumption to be positively correlated with neighbourhood average income [7], but wealthier neighbourhoods may also have better access to supermarkets and a wider variety of foods [22]. Taken together, this evidence suggests that area-level socioeconomic status (SES) may drive the observed association between dietary outcomes of interest and environmental determinants, by affecting both simultaneously.

To control for potential area-level socioeconomic confounders, we include a vector of neighbourhood control variables S_{sc} in specification (2), such as dummy variables for living in the capital city; for living in communities where garbage is collected by authorities from all homes; in communities where all homes have cold water supply; for living in communities where all homes have central steaming systems; and in communities where there are no derelict homes present. In addition, regional fixed effects μ_{rc} are included in model (2) which will account for potential confounders that vary at that geographic level. Differently from specification (1), community fixed effects cannot be included as they will be perfectly collinear with the vector X_{sc}.

Finally, a vector of individual-level determinants Z_{isc} accounts for the remaining variation at the individual level.

Results

Descriptive statistics

Table 1 presents the main descriptive statistics. In all countries, the proportion of people consuming fruit or vegetables daily or several times a week exceeds the proportion who eat them once a week, or less than once a week. This is also confirmed in formal tests (results available upon request), as the P-value is in all cases less than 0.001.

However, in only one country (Azerbaijan) does more than half of the surveyed population eat them daily; in four other countries this proportion is around a third. The table shows that the gender difference is relatively small except in Belarus (34.8% for women vs 28.8% for men) and Russia (45.1% for women vs 39.1% for men). Weighted average values for community variables used in the analysis are also presented (the weights are numbers of respondents living in respective communities).

[Table 1]

Individual determinants

Our main OLS regression results are presented in table 2, for the whole sample and separately for men and women (columns 1-3). Each year of age reduces the probability of good fruit or vegetable consumption by about 0.1%.

[Table 2]

It has already been shown in table 1 that women tend to consume more fruit and vegetables in all countries, a finding confirmed in the multivariate analysis, with women having about 4% greater probability of eating fruit or vegetables daily, compared to men. Education is positively correlated with daily consumption of fruit or vegetables, with people with tertiary education being 5.4% more likely to eat them daily, compared to those with secondary education only. Reporting a good financial situation (even controlling for wealth) is associated with about 8% greater probability of eating fruit or vegetables daily. Similarly, people whose combined wealth places them in the top 25% of the asset score in their countries are about 11% more likely to report daily fruit or vegetable consumption, compared to the bottom 25%. Living in the capital is associated with about 5.6% higher probability of reporting daily fruit or vegetable consumption. Being married is significantly positively related to the probability of reporting daily fruit or vegetable consumption. Finally, the perception that diet is not important to good health is unrelated to fruit or vegetable consumption.

Being older reduces the probability of daily eating fruit or vegetables by women, but not by men (table 2, columns 2-3). On the other hand, the role of economic situation appears

stronger among men than among women. Being married is related to greater likelihood of eating fruit or vegetables daily, but only by men. Other associations are similar for men and women.

As a robustness check, community fixed effects are included in model (1), as their inclusion should control for local heterogeneity more precisely. Estimates, reported in columns 4-6, show that there is little difference compared to the baseline estimates (columns 1-3), although parameters tend to be somewhat smaller (but still significant).

Community determinants

[Table 3]

Table 3 presents main community-level parameters. The number of snack and sweet drinks advertisements in the community is significantly negatively related to the probability of eating fruit or vegetables daily (Table 3, column 1). An additional advertisement for snacks reduces this outcome by about 3%, while another sweet drink advertisement reduces it by about 1.6%. This association is only significant (and much larger in size) for women, compared to men (compare columns 2 and 3). Living within an easy walk to a fast food outlet is associated with a very large (16%) reduction in the probability of eating fruit or vegetables daily by men (although the association is insignificant for women). Similarly, more shops selling fruit and vegetables is positively correlated with the probability of eating fruit or vegetables daily, although only significantly so for women. Furthermore, more restaurants in the community is positively correlated with daily consumption of either fruit or vegetables (although only significantly so for women).

Finally, a greater number of soft drink adverts, as well as a greater number of shops selling "crisps and sweets" is positively related to daily fruit or vegetable consumption (in the former case, the effect is significant among women, and in the latter- among men).

Additional checks

Table 4 presents ordered probit results. In columns 1-2, the focus is on individual-level determinants, and in 3-4 community variables are added. Age is negatively related to frequent fruit or vegetables consumption. Conversely, women are more likely to eat fruit or vegetables more frequently. These parameters are also positive for education, good economic status,

being married, greater wealth and negative for living in a village covariates. Finally, all community-level parameters are now insignificant (but recall that the outcome is defined differently from that in table 3, and that results are now presented separately for fruit and vegetable consumption).

[Table 4]

Discussion

Prevalence of fruit and vegetable consumption

Overall, fruit or vegetable consumption in the fSU appears inadequate, consistent with other evidence from this region [9; 23]. However, it should be noted that existing studies in the fSU region only cover some countries and do not examine determinants of dietary patterns. One exception is a recent study[17] which found that fruit and vegetable consumption in eight former Soviet countries has worsened in the past decade, especially among the poor and those in rural areas. However, it is much more descriptive than ours. While we consider community-level determinants in addition to individual ones, that study did not take advantage of the community-level dataset. It also focused mainly on the determinants of inadequate fruit and vegetable consumption (i.e., fruit once weekly or less often, or vegetables once weekly or less often), while we consider determinants of good (i.e., daily/almost daily fruit or vegetable consumption). Another (less important) difference is that they considered prevalence and determinants of fruit and vegetable consumption separately by fruit and vegetables, while we aggregated consumption. Our approach is more relevant in our view, because international guidelines prescribe 400 grams of combined fruit or vegetable consumption, rather than separately for fruit or vegetables.

Some findings are unexpected: despite its large agricultural sector and warm climate, Moldova has the fewest people reporting fruit or vegetable consumption more than once a week. This may be because it is one of the poorest countries in the fSU, with a rapidly growing share of its agricultural output now being exported [24]. Interestingly, only 0.1% of respondents living in Moldova agreed with the statement that good diet is not important for health (see Annex). At the same time, in Russia, where a relatively large proportion of people reported daily fruit or vegetable consumption, 1.85% (the highest number) agreed with this statement. This gap between the perceived importance of good diet and actual fruit or vegetable consumption merits further study, although research elsewhere has found a

similar disconnect between knowledge and practice [25]. ,.It should also be noted that these proportions are estimated for a very small number of respondents- 54 out of 2,922 in the case of Russia, for example

Socioeconomic and demographic determinants

Our findings are consistent with other evidence on the social patterning of fruit and vegetable consumption (SES) [7; 26; 27; 28; 29]. Thus, variables such as education, household economic situation and household size, as well as wealth, are all independently associated with daily fruit or vegetable consumption.

Similarly, the lower probability of daily fruit or vegetable consumption with increasing age is consistent with some previous studies [30] but not all[28]. While older people may have less disposable income to spend on nutritious food, it is also likely that age has an independent effect, as a range of socioeconomic variables are controlled for in all regressions reported in table 1. One potential explanation is that older people living in the fSU may prefer to eat more traditional diets, which in many countries in that region are based on meat and carbohydrate-rich foods such as potatoes and grains.

Like us, some previous studies also found that women, and those who are married, are more likely to eat enough fruit and vegetables [7; 28], including in Russia and several Central and Eastern European countries[31; 32]. This is in line with findings that in Russia, for example, women are much less likely to engage in dangerous health behaviours such as smoking and excessive alcohol consumption[33], which suggests that women living in fSU may be more health-conscious then men. Since in that region, women traditionally spend more time cooking then their husbands, this may also explain why married people are more likely to eat healthily.

Few studies have examined how fruit and vegetable consumption varies among those living in rural and urban areas. One study from the USA found people in rural areas more likely to consume fruit and vegetables [34]; in contrast, a European study found living in rural areas associated with lower consumption [7]. There is no significant association in the OLS models reported in table 2, but living in rural areas is negatively related to fruit or vegetable consumption in the ordered Probit regression (table 4). This finding may look somewhat counter-intuitive but again one possible explanation is the preference for the traditional diet rich in grains, potato and meat (recall that potatoes are excluded from the definition of vegetable consumption).

Food stores and supermarkets

Theoretically, greater availability of food stores and supermarkets may increase access to fruits and vegetables, thus contributing to increased consumption, for reasons such as lower travel and time costs of obtaining such foods; stimulation of consumption by visual cues; and the effect of exposure on food preference [35]. However, better access to supermarkets and food stores may also provide greater exposure to unhealthy foods, and therefore, *a priori*, the overall effect is far from clear.

The available evidence does not clearly support the assertion that better access to food stores improves fruit and vegetable consumption [36]. However, most of the existing evidence is derived from cross-sectional studies [37]conducted in high-income countries, so their findings may not be transferable to poorer countries in the former Soviet Union. Adding to the complexity, several studies found consistent positive associations between healthy dietary patterns and supermarket access in the US [38], but not in Europe [39]. One potential explanation is the greater locational segregation in the US [38], with supermarkets distributed more evenly among poor and wealthy districts in Europe, or because of better access to retail food outlets in Europe due to better public transport.

Although our data do not capture the number of supermarkets in the neighbouring area, they show that access to shops selling fruit and vegetables is positively and significantly correlated with daily fruit or vegetable consumption for women. One potential explanation is that it is not really the proximity of additional stores selling fruit and vegetables that influences fruit and vegetable consumption, but rather the fact that they are situated in wealthier areas, where people may be better educated about the importance of nutritious food, and have higher incomes to purchase them [22]. In addition, access to remotely located stores in the fSU may be limited due to the lack of convenient and affordable public transport, and scarcity of cars. Nevertheless, one can be more optimistic about a causative interpretation of our findings because regional fixed effects are also included in the analysis, which should account for interregional variations in socioeconomic indicators. In another middle income country - Brazil - a study that also controlled for area socioeconomic status found a similar positive correlation between regular fruits and vegetables intake and density of food markets specialising in fruit and vegetables [40].

It should also be mentioned that the consequences of better access to supermarkets can differ from those of better access to convenience stores, and that our dataset does not make a clear distinction between these two kinds of stores. Thus, some studies have found

either no, or negative associations between availability of convenience stores and fruit and vegetable consumption [38; 39]. This can be because such stores may provide less choice of fresh fruit and vegetables, and thus encourage people to buy more unhealthy food items. Alternatively, such stores may be located in more economically disadvantaged areas, and thus the observed association between dietary patterns and convenience store access may be partly driven by variations in neighbourhood socioeconomic status. Although there is no proxy for convenience store availability, there is a variable measuring the number of stores selling sweets and crisps in the neighbourhood. While there is no significant association between this variable and daily fruit or vegetable consumption for the whole sample and women only, surprisingly, it is significant and positive for men. Nevertheless, it is important to emphasize that these stores may not necessarily be limited in their supply of fruit or vegetables (and thus not properly fall in the category of convenience stores), and therefore one should not over-interpret this finding.

Nutrition and advertising

The relationship between food advertising and dietary behaviours is also of interest, as sums spent on advertising are very large, most promoting unhealthy foods [41]. However, the existing literature on the effect of food advertising on either fruit or vegetable consumption is limited, and tends to focus on adolescents, as well as on television advertising only [42]. A considerable part of this literature is based on small scale experimental studies of questionable generalisability.

We find billboard advertising of snacks and sweet drinks (including juices) to be significantly negatively related to daily fruit or vegetable consumption. While this does not prove that billboard advertising for unhealthy foods causes less consumption of fruit or vegetables (as it may well be that such advertisements are deliberately placed in communities where unhealthy eating is more prevalent), the fact that the effect is significant even with the inclusion of regional effects, as well as of a range of both community and individual controls, does increase confidence in our findings. Also the fact that this association is much stronger for women in both cases suggests that local confounders are unlikely to be the main explanation. Surprisingly, billboard adverts for soft drinks are positively related to daily fruit or vegetable consumption (although not for men). One can speculate that the positive sign found for soft drinks advertising might be due to a complementarity or substitutability between fruit and vegetables, and other goods. For instance, while juice drinks could be

perceived as substitutes for fruit and so consumed as an alternative, soft drinks or sweets could instead be more often consumed with fruit. We could not find any other studies that measured this association.

Fast food and restaurants

The role played by availability and access to fast food outlets is also unclear. Thus, although, theoretically, one can expect easier access to fast food stores to be associated with worse dietary patterns [43], such findings may be due to community-level confounding by neighbourhood socioeconomic status, with less well-off communities more likely to provide access to fast food establishments.

Empirical evidence on this topic has so far been inconclusive. One New Zealand study found neighbourhood access to fast-food establishments unrelated to fruit and vegetable consumption [38]. The previously cited study from Brazil found no association between fast food outlet density and fruit and vegetable intake [40]. Several US studies found easier access to fast-food outlets to be negatively related to diet-related outcomes [38]. Our finding of a significant negative association between the ease of access to fast food outlets, and the probability of daily fruit or vegetable consumption for men is thus more consistent with the US studies.

As for easier access to full-service restaurants, theoretically it is unclear how they may affect dietary attitudes and behaviours. On one hand, the effect may depend on the food choice on offer (traditional menus are quite heavily meat and potato-based in many fSU countries). Conversely, any empirical finding of an association between these variables should be tempered by the risk of confounding by neighbourhood-level characteristics. As it is, the existing empirical evidence is more limited than for fast food outlets. One study found, for example, that better access to a full-service restaurant was related to lower intake of saturated fat among black Americans [41]. Another study reached a different conclusion after finding that away from home eating (with both restaurant and fast food consumption) was related to worse quality of diet [22]. Our finding of a small positive association between the number of local food restaurants, and greater fruit or vegetable consumption in the fSU countries (especially for women) adds to this growing literature.

Data limitations

Although our rich data set helps alleviate potential endogeneity concerns, there are certain limitations. The questionnaires were not primarily designed to assess diet and only recorded whether respondents had eaten any fruit or vegetables during the past week and not how often. Although eating fruit or vegetables daily or almost daily may still not guarantee that adult people eat their recommended amount of 400 grams a day, at least this group is more likely to meet fruit and vegetable targets. The need for data collected with food frequency or dietary recall questions is clear [44].

In addition, the fruit and vegetable consumption variables have not been validated for HITT study. Having said that, very similar variables have been used in another published article [45] . A possible concern regarding the external validity of our results comes from the fact that data was collected in the spring, between March and May, a period when fruit and vegetable supply will be in relatively poor supply compared with June to September. This timing may lead to underestimate the effect of proximity to stores on fruit and vegetable consumption.

Also, observed associations may not be causal. For example, community-level exposure to advertising may be determined by the perceived attractiveness of the neighbourhood demographics to marketing organizations and placement of stores may also depend on the perceived wealth of the community. Having said that, this issue is addressed in two main ways: first, as all the variables of interest are included in specification (1) simultaneously, partial regression coefficients obtained for each covariate demonstrate the association adjusted for any potential confounding by observable variables; second, by including community fixed effects in equation (1), and regional fixed effects in equation (2), any additional area-level confounding affecting both the covariates of interest, and the outcome variable is controlled for.

Some of the community-level indicators may also be imperfect measures of the variables of interest. Thus, the dataset lacks information on size of outlets. Moreover, it is possible that the same outlet may sell both healthy (e.g. fruit and vegetables, and unhealthy (e.g. biscuits) items. Nevertheless, given these limitations, it is encouraging that our results are largely consistent with prior expectations.

Conclusions

This is the first study to examine both the individual and community level determinants of fruit and vegetable consumption in nine fSU countries. It confirms the inadequacy of

consumption in this region and sheds light on which groups are most vulnerable: namely men, those at older ages, with less education, and fewer financial resources. However, beyond these individual attributes, the local food economy also plays a role. Taken together, these findings provide potential entry points for policy interventions.

Table 1 Selected descriptive statistics, by country (2010)

	Armenia	Azerbaijan	Belarus	Georgia	Kazakhstan	Kyrgyzstan	Moldova	Russia	Ukraine
Response rates, %	60.1	56.8	48.1	82.9	47.3	78.4	74.8	59.2	60.1
Fruit or vegetable consumption									
Men and women									
Daily, %	49.8	55.5	32.2	32.6	47.4	36.9	30.4	42.7	48.9
Several times a week, %	36.2	29.5	42.9	41.7	30.8	33.4	34.2	42.3	34.3
Once a week, %	12.1	12.8	15.4	15.9	13.7	16.6	16.8	12.5	11.2
Less than once a week, %	1.9	2.2	9.6	9.8	8.1	13.0	18.6	2.6	5.6
Women only									
Daily, %	50.4	55.8	34.8	34.0	49.5	37.6	30.7	45.1	49.7
Several times a week, %	35.1	30.0	43.1	40.4	29.3	31.6	34.2	42.2	33.7
Once a week, %	12.3	11.7	13.7	15.2	13.4	17.4	16.9	10.6	10.7
Less than once a week, %	2.2	2.4	8.4	10.4	7.9	13.3	18.2	2.1	6.0
Men only									
Daily, %	49.1	55.0	28.8	30.1	45.0	36.2	30.0	39.1	47.8
Several times a week, %	37.5	29.0	42.6	44.1	32.4	35.4	34.2	42.3	35.2
Once a week, %	11.8	14.2	17.4	17.0	14.2	15.7	16.7	15.3	11.8
Less than once a week, %	1.6	1.8	11.1	8.9	8.4	12.6	19.1	3.3	5.2
Community-level determinants									
N of fast food adverts	3.0	3.5	0.0	0.5	0.1	0.5	3.5	0.6	1.3
N of snack adverts	2.4	4.5	1.1	0.5	0.5	0.3	3.0	2.0	1.8
N of soft drinks adverts	2.4	2.3	2.3	2.0	0.7	1.1	3.7	2.0	4.5
N of sweet drinks/juices adverts	4.0	2.0	3.3	2.5	1.8	2.3	9.1	3.3	4.5
N of shops selling crisps and sweets	6.5	6.5	8.8	6.9	6.7	6.7	9.7	7.9	8.2
N of shops selling F&V	4.9	5.0	8.2	3.4	4.8	4.1	6.4	6.1	5.0
N of local restaurants	3.4	2.4	2.7	2.2	2.6	0.8	4.9	1.9	2.8

Source: Health in Times of Transition (HITT) dataset, 2010. In all columns, mean values are presented. Summary of individual-level data represents average proportion of people eating fruit or vegetables daily, several times a week, once a week, less than once a week. Community data represents mean values per community, weighted by community size. Each community represents a separate primary sampling unit, equivalent to a "rayon", or a small administrative region.

Table 2 Individual determinants of daily/almost daily fruit or vegetable consumption

	All		Women		Men		All		Women		Men	
	Coefficient†	SE	Coefficient†	SE	Coefficient†	SE	Coefficient‡	SE	Coefficient‡	SE	Coefficient‡	SE
Good diet not important	0.032	0.045	0.025	0.063	0.041	0.057	-0.024	0.038	0.043	0.054	-0.077	0.055
Age	-0.001***	0.000	-0.001***	0.000	0.000	0.000	-0.001***	0.000	-0.002***	0.000	-0.001**	0.000
Female	0.041***	0.008	-	-	-	-	0.039***	0.007	-	-	-	-
Primary	-0.072***	0.015	-0.073***	0.02	-0.066***	0.020	-0.063***	0.013	-0.078***	0.018	-0.037*	0.021
Secondary	-0.054***	0.01	-0.053***	0.013	-0.050***	0.014	-0.035***	0.009	-0.051***	0.012	-0.017	0.014
Good economic situation	0.081***	0.012	0.065***	0.015	0.098***	0.016	0.079***	0.01	0.073***	0.014	0.080***	0.015
Household size	0.000	0.003	-0.002	0.003	0.002	0.004	-0.002	0.002	-0.005*	0.003	0.001	0.004
Married	0.023***	0.008	0.015	0.011	0.026*	0.013	0.031***	0.007	0.014	0.01	0.046***	0.013
Village	-0.018	0.016	-0.006	0.018	-0.033*	0.019	-	-	-	-	-	-
Capital	0.056***	0.02	0.053**	0.023	0.062**	0.024	-	-	-	-	-	-
Asset2	0.02	0.012	0.019	0.015	0.019	0.017	0.025**	0.011	0.032**	0.015	0.013	0.017
Asset3	0.056***	0.013	0.058***	0.017	0.050***	0.019	0.053***	0.011	0.063***	0.016	0.032*	0.018
Asset4	0.114***	0.014	0.135***	0.018	0.091***	0.019	0.106***	0.011	0.132***	0.016	0.070***	0.018
Observations	17,305		9,778		7,527		17,305		9,778		7,527	

Source: Health in Times of Transition (HITT) dataset, 2010.
*Significant at 10%; **significant at 5%; ***significant at 1%.
Cluster-robust standard errors are presented. All specifications also include country dummies.
†OLS: ordinary least squares model
‡CFE: community fixed effects model

Table 3 Community determinants of daily/almost daily fruit or vegetable consumption

	All		Women		Men	
	Coefficient†	SE	Coefficient†	SE	Coefficient†	SE
Food adverts	0.02	-0.018	0.028	-0.02	0.013	-0.025
Snack adverts	-0.031***	-0.011	-0.040***	-0.011	-0.019	-0.015
Soft drinks adverts	0.023*	-0.012	0.032***	-0.011	0.027	-0.017
Sweet drinks/juice adverts	-0.016*	-0.008	-0.025**	-0.011	-0.015	-0.009
Shops selling crisps and sweets	0.005	-0.008	-0.011	-0.009	0.022**	-0.009
Shops selling fruit and vegetables	0.009	-0.01	0.023**	-0.012	-0.004	-0.012
Number of local food restaurants	0.015	-0.009	0.029**	-0.012	-0.005	-0.01
Easy walk to fast food outlet	-0.069	-0.046	-0.012	-0.064	-0.161**	-0.062
Observations	1,680		946		734	

Source: Health in Times of Transition (HITT) dataset, 2010.
*Significant at 10%; **significant at 5%; ***significant at 1%.
Cluster-robust standard errors are presented.
†Ordinary least squares (OLS) parameter estimates are presented. All specifications include the same control variables as in table 2. In addition, all specifications include the following community control variables: dummy indicators for living in communities where no homes have garbage collected by authorities from all homes; in communities where no homes have cold water supply; for living in communities where no homes have central steaming systems; and in communities where there are no derelict homes present. Finally, all specifications include regional fixed effects.

Table 4 Ordered Probit results for fruit or vegetable consumption†, without and with community determinants

	Vegetables		Fruit		Vegetables‡		Fruit‡	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
Good diet not important	-0.071	0.103	0.032	0.106	0.265	0.363	0.072	0.293
Age	-0.002***	0.001	-0.004***	0.001	-0.002	0.002	-0.004**	0.002
Female	0.073***	0.017	0.111***	0.017	-0.003	0.053	0.091	0.06
Primary	-0.226***	0.035	-0.226***	0.036	-0.079	0.099	-0.166	0.112
Secondary	-0.147***	0.022	-0.185***	0.022	-0.155**	0.065	-0.180***	0.069
Good economic situation	0.186***	0.029	0.298***	0.028	0.219***	0.078	0.370***	0.07
Household size	0.002	0.006	0.005	0.007	0.004	0.023	0.01	0.017
Married	0.060***	0.019	0.066***	0.019	0.057	0.062	0.043	0.06
Village	-0.077**	0.038	-0.209***	0.035	0.066	0.12	0.022	0.115
Capital	0.074	0.049	0.108**	0.047	0.318**	0.161	0.250*	0.144
Asset2	0.084***	0.028	0.173***	0.029	0.099	0.084	0.216**	0.085
Asset3	0.170***	0.03	0.279***	0.031	0.149	0.092	0.202**	0.093
Asset4	0.334***	0.032	0.390***	0.033	0.347***	0.094	0.418***	0.102
Number of food adverts	-	-	-	-	0.049	0.039	-0.03	0.032
Number of snack adverts	-	-	-	-	-0.037	0.026	0.007	0.023
Number of soft drinks adverts	-	-	-	-	0.033	0.028	0.007	0.021
Number of juice adverts	-	-	-	-	-0.007	0.017	0.021	0.014
Number of shops selling sweets & crisps	-	-	-	-	-0.003	0.016	-0.012	0.011
Number of shops selling fruit & vegetables	-	-	-	-	0.009	0.02	0.022	0.014
Number of local food restaurants	-	-	-	-	0.009	0.016	-0.017	0.013
Easy walk to fast food outlet	-	-	-	-	-0.097	0.103	-0.011	0.099
Observations	17,395		17,372		1,692		1,685	

Source: Health in Times of Transition HITT dataset, 2010.
*Significant at 10%; **significant at 5%; ***significant at 1%.
Original parameters are presented. Cluster-robust standard errors are presented.
†The outcome variable range is from 1 less than once a week to 4 daily/almost daily.
‡ Specifications include the following community control variables: dummy variables for living in communities where garbage is collected by authorities from all homes; in communities where all homes have cold water supply; for living in communities where all homes have central steaming systems; and in communities where there are no derelict homes present.

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