

## The availability, affordability and consumption of fruits and vegetables in 18 countries across income levels: Findings from the prospective urban rural epidemiology (PURE) study

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### Abstract

Several international guidelines recommend the consumption of two servings of fruits and three servings of vegetables per day, but their intake is assumed to be low worldwide. We aimed to work out the extent to which such low intake is said to availability and affordability. We assessed fruit and vegetable consumption using data from country-specific, validated semi-quantitative food frequency questionnaires within the prospective urban rural epidemiology (PURE) study, which enrolled participants. We documented household income data from participants in these communities; we also recorded the range and non-sale prices of fruits and vegetables from grocery stores and market places between Jan 1 2009 and Dec 31 2013. We determined the value of fruits and vegetables relative to income per household member. Rectilinear accidental belongings models, adjusting for the clustering of households within communities, were wont to assess mean fruit and vegetable intake by their relative cost. Of 143,305 participants who reported plausible energy intake within the food frequency questionnaire, mean fruit and vegetable intake was 3.76 servings (95% CI 3.66-3.86) per day. Mean daily consumption was 2.14 servings (1.93-2.36) in low income countries (LICs), 3.17 servings (2.99-3.35) in lower-middle-income countries (LMICs), 4.31 servings (4.09-4.53) in upper middle-income countries (UMICs), and 5.42 servings (5.13-5.71) in high-income countries (HICs). In 130,402 participants who had household income data available, the value of two servings of fruits and three servings of vegetables per day per individual accounted for 51.97% (95% CI 46.06-57.88) of household income in LICs, 18.10% (14.53-21.68) in LMICs, 15.87% (11.51-20.23) in UMICs and 1.85% (-3.90 to 7.59) in HICs (P trend=0.0001). altogether regions, a better percentage of income to satisfy the rules was required in rural areas than in urban areas (p<0.0001 for each

pairwise comparison). Fruit and vegetable consumption among individuals decreased as the relative cost increased (P trend=0.00040). The consumption of fruit and vegetables is low worldwide, particularly in LICs, and this is associated with low affordability. Policies worldwide should enhance the availability and affordability of fruits and vegetables.

Most nutritional guidelines recommend the consumption of a minimum of two servings of fruits and three servings of vegetables per day.<sup>1, 2</sup> However, an outsized proportion of people don't meet these targets.<sup>3-5</sup> an improved understanding of the factors that affect fruit and vegetable consumption is important to improving the diet quality of populations. Food cost has been shown to affect dietary intake in developed countries, <sup>6, 7</sup> but similar data for low-income countries (LICs) and middle-income countries (MICs) are sparse. High food cost might particularly affect affordability among households spending a substantial proportion of their income on food.<sup>8,9</sup> Increases within the cost of food are shown to end in food-based coping strategies like reductions within the quantity, quality, and variety of food selections, and consumption of increased quantities of cheap, energy-dense foods.<sup>10-12</sup> Determining the affordability of essential foods like fruits and vegetables in countries with different levels of economic development is vital . During this study, we aimed to document the supply cost of fruits and vegetables in community grocery stores and market places, and therefore the affordability of meeting dietary guidelines aimed at fruitlet and vegetable intake in 18 countries with different income levels. We similarly intended to narrate the affordability of fruits and vegetables to their consumption.

Methods: Study design and sample selection Between Jan 1, 2003, and Dec 31, 2013, the potential Urban Rural Epidemiology (PURE) study enrolled 157 254 adults aged 35-

70 years in 667 communities from 18 countries on five continents. Countries were selected from four income strata consistent with the planet Bank classification in 2006 on the idea of gross value per person. There have been four LICs (Bangladesh, India, Pakistan, and Zimbabwe), four lower-middle income countries (LMICs; China, Colombia, Iran, Occupied Palestinian Territory), seven upper-middle income countries, then three great revenue republics (HICs; Canada, Sweden, United Arab Emirates). an in depth description of participant, community, and country selection has been published elsewhere.<sup>13, 14</sup> within the PURE study, 147 938 participants completed country-specific, validated semi-quantitative food frequency questionnaires (appendix p 6).<sup>15–22</sup> of those individuals, we included those that had plausible energy intake (500–5000 kcal per day) in our analyses of fruit and vegetable consumption. For analyses of food availability and affordability, we collected information on the value of a minimum of one fruit and one vegetable in each PURE community between Jan 1, 2009, and Dec 31, 2013. A 1 km observation walk was done by staff during a centrally located area within each community. Within each area, non-sale prices (ie, retail prices before any discounts) were collected from the grocery or market place located in closest proximity to the observation walk zone for the subsequent fruits and vegetables: apples, oranges, bananas, pears, carrots, tomatoes, and cabbage. A checklist of 48 sorts of fruits and 59 sorts of vegetable was went to assess the variability of fruits and vegetables available. Additional grocery stores or market places within the 1 km area were visited if staff were unable to gather the value of the fruits and vegetables. The entire number of sorts of fruit and vegetable available purchasable in each community was calculated to assess the range. Moreover, we composed domestic revenue statistics from members in these communities. The methods went to calculate daily income, and fruit and vegetable costs and consumption are shown in appendix p 12. The study variables and their unit of study are summarised.

Statistical analysis- The affordability of two servings of fruits and three servings of vegetables per day was assessed using the smallest amount expensive fruit and vegetable available purchasable within each community. Additionally, the affordability of buying five servings of the foremost cost effective fruit or vegetable was assessed to estimate the most

optimistic scenario of affordability that's reflective of substituting either sort of produce to succeed in five daily servings. To define affordability, we used a threshold of but 20% of household income per household member required to get two servings of fruits and three servings of vegetables per day for each household member. We used this demarcation point for affordability because we found that few households in HICs used quite 20% of their income within the purchase of the recommended number of servings. Furthermore, when other various thresholds were explored, we found an equivalent pattern of unaffordability across economic regions. We also calculated the proportional increase in food expenditure necessary to satisfy the recommended intake of fruits and vegetables among individuals who didn't meet this target.

Results: Out of 147 938 PURE education contributors who accomplished the food frequency questionnaires, 143 305 (97%) had plausible energy intake and were included in our analyses of fruit and vegetable intake. These participants and therefore the participants who were included in community assessments generally had similar characteristics (see appendix pp 16–19 for a summary of total household size and composition, including household members not participating within the PURE study, by country and economic region). The median age of those 143 305 participants was 50.0 years (IQR 34.0–66.0), and men and ladies were equally represented. The mean body-mass index was 25.8 kg/m<sup>2</sup> (SD 5.2), 29 852 (21%) of participants were current smokers, and quite half (55%) had low or moderate physical activity levels. At the community level, absolutely the cost (adjusted by purchasing price parity) of 1 serving of vegetables was cheapest in LICs and costliest in HICs (p trend=0.0023). Conversely, the adjusted cost of 1 serving of fruit was highest in LICs (p trend=0.0061). the value of 1 serving of vegetables relative to income per household member was quite 19 times higher in LICs than in HICs (p trend=0.00029), and therefore the relative cost of 1 serving of fruit was 50 times higher in LICs than in HICs (p trend=0.00011). The relative cost of fruit was costlier than that of vegetables in each region. Mean daily income per household member was greatest in HICs and lowest in LICs, and greater in urban communities than rural communities across all income regions