Leveraging a National Big Data Source to Measure Cost and Affordability Gaps between Current and Healthy Diets: an analysis for Argentina during the Pandemic Year

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Abbreviations (if needed): CD: Current Diet; HD: Healthy Diet; CND: Chronic Noncommunicable Diseases.

Introduction

Consuming healthy diets is a priority to reduce the prevalence of Chronic Noncommunicable Diseases (CND), particularly obesity, diabetes, and cardiovascular disease[1] [2]. Implementing policies for promoting healthy diets is highly important in the fight against the coronavirus disease 2019 (COVID-19) pandemic considering that obesity is a modifiable risk factor for COVID-19-related mortality[3].

There are many factors that affect population diets. Among them, the cost and affordability of food have been highlighted as one of the most important barriers for the population to access a healthy diet, in some

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[1] United Nations System Standing Committee on Nutrition, 2018. *Enfermedades No Transmisibles, Dietas y Nutrición*. Retrieved from https://www.unscn.org/uploads/web/news/document/NCDs-brief-SP-WEB-ok.pdf.

[2] WHO (2013). Dieta, nutrición y prevención de enfermedades crónicas: informe de una Consulta Mixta de Expertos OMS/FAO. Technical Report Serie, N° 916. WHO: Geneva.

[3] Katsoulis, M., Pasea, L., Lai, A. G., Dobson, R. J. B., Denaxas, S., Hemingway, H., Banerjee, A. (2020). Obesity during the COVID-19 pandemic: both cause of high risk and potential effect of lockdown? A population-based electronic health record study. Public Health. 2021 Feb;191:41-47. doi: 10.1016/j.puhe.2020.12.003.

cases influencing food choice to a greater extent than other factors such as flavor, promotions and convenience[4][5][6][7][8].

The most recent FAO reports emphasize that while the world still faces challenges for food access, these are even more important constraints for accessing healthy food[9]. In this sense, the cost and affordability of healthy diets are critical determinants of food access and obesity or malnutrition. Fiscal policies are among the recommended measures to tackle malnutrition. Monitoring food prices is relevant in order to develop evidence-based policies and inform fiscal responses.

The promotion of healthy eating habits in Argentina has become essential in the fight against non-communicable diseases (NCDs) associated with excess weight: according to the latest National Risk Factor Survey[10], only 6% of the population meet daily fruit and vegetable intake recommendations. Furthermore, over 60% of adults are overweight and 40% of children and adolescents between 5 and 17 years old are overweight or obese. In this frame, understanding the factors that prevent healthier consumer choices becomes critical.

The aim of this paper is to present an analysis of the difference between the cost and affordability of current and healthy diets for the Argentinean population, and its evolution during 2020, a year characterized by the COVID-19 pandemic.

Methods

Diets approach

Model diets were developed considering a typical household structure -i.e. a 45 year-old man and woman, a 14 year-old boy and a 7 year-old girl- for a time period of two weeks, as recommended by the INFORMAS framework. INFORMAS is a global network of organizations and researchers committed to the promotion of healthy food environments worldwide, with the ultimate goals of reducing obesity, diet-related NCDs and their related inequalities[11].

The model current diet (CD) was based on the most consumed foods, defined as those products that were purchased by at least 5% of households as reported by the National Household Expenditure Survey 2012-2013 (ENGHo), an approach that has been used in another study also based on the INFORMAS protocol. According to this protocol, the "common foods" identified are those considered culturally acceptable, commonly eaten and widely available.

Once the most commonly consumed foods were identified, they were grouped as per the Dietary Guidelines for the Argentinean Population (GAPA) into: fruits and vegetables; legumes, cereals, potatoes, bread and pasta; milk, yoghurt and cheese; meat and eggs; oils, nuts and seeds; and discretionary foods. These groups were further subdivided into categories to achieve higher specificity of our diet cost model. Despite not being included in GAPA food groups, non-sugary beverages, alcohol beverages and salt were also considered to model CDs because they were part of the most consumed foods. The ENGHo also provides an estimate of the amount of specific foods (g) consumed by an "equivalent adult", a unit that standardizes energy requirement to that of an adult male 30 to 60 years-old (2.750 kcal/day). The amount of different food groups (g) consumed by a typical household were

[4] Lennernäs, M., Fjellström, C., Becker, W., Giachetti, I., Schmitt, A., De Winter, A., Kearney, M. (1997). *Influences on food choice perceived to be important by nationally-representative samples of adults in the European Union.* Eur J Clin Nutr 1997, 51.

[5] Glanz, K., Basil, M., Maibach, E., Goldberg, J., Snyder, D. (1998). Why Americans eat what they do: taste, nutrition, cost, convenience, and weight control concerns as influences on food consumption. J Am Diet Assoc 1998, 98(10):1118-1126.

[6] DiSantis, K.I., Hillier, A., Holaday, R., Kumanyika, S. (2016). Why do you shop there? A mixed methods study mapping household food shopping patterns onto weekly routines of black women. International Journal of Behavioral Nutrition and Physical Activity 2016, 13(1):11.

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[10] Instituto Nacional de Estadística y Censos - I.N.D.E.C. 4° Encuesta Nacional de Factores de Riesgo. Resultados definitivos. [Internet]. 1ª ed. Ciudad Autónoma de Buenos Aires, Argentina: Instituto Nacional de Estadística y Censos - INDEC y Secretaría de Gobierno de Salud de la Nación; 2019 [citado 22 de julio de 2021]. Disponible en: https://www.indec.gob.ar/ftp/cuadros/publicaciones/enfr_2018_resultados_definitivos.pdf

[11] INFORMAS modules, resources, and protocols. Available at https://www.informas.org.

estimated in reference to this standard unit, following the equivalent adult conversion table provided by the National Statistics and Census Institute (INDEC) for males and females of different ages and resting on the assumption that all household members consume the same foods but in different quantities. Total energy (kcal), carbohydrates (g), total sugars (g), sugars (g), total fat (g), saturated fat (g), protein (g), fiber (g) and sodium (mg) intake were calculated based on these food amounts, using nutrient content data from a previous study.

The healthy diet (HD) was also designed on the basis of the most consumed foods but including a greater variety of foods with better nutritional quality, such as lean meats and fish, wholemeal bread and cereals, and low-fat dairy products. These selections were performed in view of the nutrient and food group targets set forth by the UN's Food and Agriculture Organization and World Health Organization (FAO/WHO) nutritional standards and GAPA.

Since it is very difficult to design model diets meeting these targets exactly, minimum and maximum constraints for each specified food group and nutrient content were established as per the INFORMAS DIETCOST program rationale[12], that allows for a +/- 30% margin for nutrient requirements and +/- 1.5% for energy yields. Energy intake targets were kept constants for both the CD and HD model diets.

Nutrition professionals in our research team elaborated a two-week menu (including breakfast, lunch, afternoon snack and dinner) for the typical household and calculated the amount for each food category necessary to achieve energy (kcal), macronutrients (g), fiber (g) and sodium (g) intake levels consistent with ENGHo estimates for current intake by food group (CD) or meeting nutritional targets (HD). This process resulted in a list of weight and energy yields for 112 different products belonging to 28 food categories, included in different proportions in CD and HD.

Finally, a second healthier diet -HD2- was modelled by reducing the total energy yield of the HD diet. Although the original aim was to achieve an 8% energy reduction, as has been done in comparable studies[13][14], it was not possible to do so and still meet food category weight and energy yield targets. Thus, the HD2 -reduced-energy healthy diet- represented a 6.3% energy reduction vs. CD/HD. These reductions were conducted across all food groups to maintain the same relative energy participation per food group as the HD. For example, if fruit represented 10% of the total energy yield in HD, then it also accounted for 10% of the HD2.

Estimations of Diet cost

In order to ensure maximum reliability of the information, prices for all the products included in both diets were estimated from *Precios Claros*. Precios Claros is a website developed by the National Government of Argentina in order to offer an Electronic Price Advertising System which is continually updated. The website provides information on product prices in different retailers and wholesalers throughout the country, with the objective to inform the population so they can make price comparisons for their entire shopping list in different nearby stores and thus be able to choose where and how to buy better. On the background of the website, there are records of an enormous price data set that is extremely useful for the purpose of our study. An open-source project developed by Open Data Cordoba published records of price data sets collected by applying the Web Scraping method to the Precios Claros website[15]. Although the price information available covers the entire country, we limited this first analysis to the Greater Buenos Aires Region, which includes almost 40% of the total population of the country. We extrapolated the food prices along 2020 by applying the Food Groups Price variability (Consumer Price Index - GBA). We calculated the costs of diets for different months based on the estimated food prices.

Two approaches were used to estimate diet costs. The first approach considered an equal total energy yield from the CD and the HD as calculated from ENGHo average food consumption data. The second approach consisted

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[12] INFORMAS: DIETCOST Programme Manual for Users. Available in:
https://auckland.figshare.com/articles/journal_contribution/DIETCOST_programme_manual/5701018

[13] Mackay S, Buch T, Vandevijvere S, Goodwin R, Korohina E, Funaki-Tahifote M, et al. Cost and affordability of diets modelled on current eating patterns and on dietary guidelines, for New Zealand total population, Māori and Pacific households. Int J Environ Res Public Health. 2018;15(6):1255. https://doi.org/10.3390/ijerph15061255.

[14] Lee AJ, Kane S, Ramsey R, Good E, Dick M. Testing the price and affordability of healthy and current (unhealthy) diets and the potential impacts of policy change in Australia. BMC Public Health. 2016;16(1):315. https://doi.org/10.1186/s12889-016-2996-y.

[15] Open Data Cordoba website: https://www.opendatacordoba.org/.

of estimating the cost of a healthy diet that would result in a 6.3% reduction in total energy intake compared to the CD (HD2). This approach is consistent with that adopted by other studies using a similar methodology[16][17].

A linear programming routine using Microsoft Excel's Solver was used to generate three different product basket options for the CD, HD and HD2, based on the fortnightly menus designed in the previous step. The model was a simple linear programming routine done in Microsoft Excel 2016 to select a combination of products from a predetermined list in order to meet food group weight targets while simultaneously meeting energy yield constraints. Since the macro- and micro-nutrient targets are already considered in the design of food group intake targets as per GAPA and WHO/FAO recommendations, our model did not explicitly include nutrient content thresholds.

The nine resulting diet models (three per diet type: CD, HD, and HD2) were controlled and modified if necessary by our nutrition professionals to ensure that the quantities obtained for each product made sense from a nutritional and cultural point of view and to have an adequate representation of each food category according to their frequency of consumption.

Finally, a Monte Carlo simulation was performed considering the cost of the 28 food groups included in the nine resulting diet models previously generated. The simulation included 10,000 iterations per diet type, resulting in 30,000 combinations of food groups options.
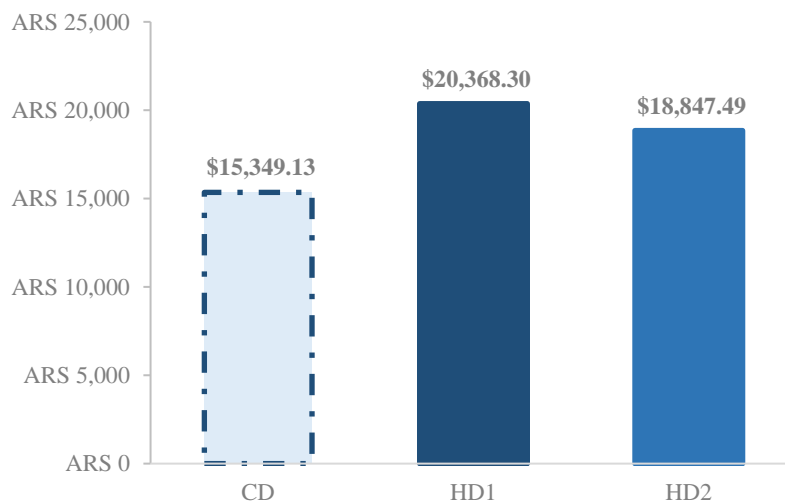
Affordability was measured as the percentage contribution of diet cost vs. average household income in average. For estimating household's income, the INDEC's Permanent Household Survey was used.

To analyze food price evolution, we used the consumer price index from Greater Buenos Aires (INDEC). We applied the index to the April 2020 Database at the food group level, which was the smallest possible level of data disaggregation.

Results

For April 2020, when HDs and CDs presented the same energy value (119,797.6 kcal ±1.5%) the estimated average cost of HDs was 32.7% higher than the CDs (AR$ 20,368 vs AR$ 15,349). When HD and CD presented different energy values, the estimated cost of HD2 was 22.8% higher than CD (Figure 1).

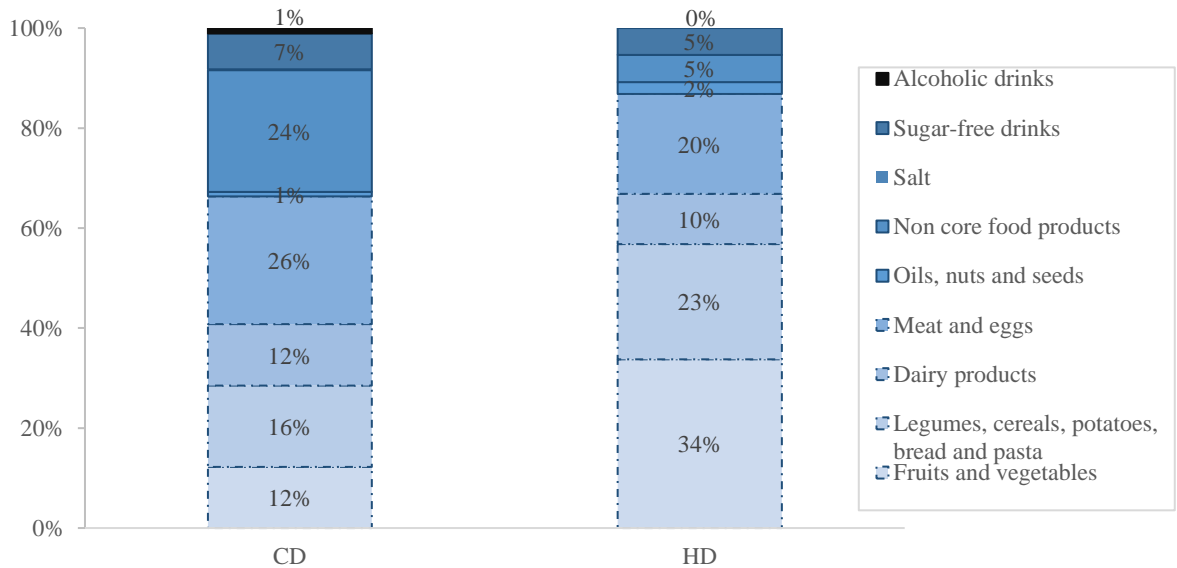**Figure 1: Cost of current and healthy diets. April 2020. Greater Buenos Aires**

Source: Own estimation.

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[16] Mackay S, Buch T, Vandevijvere S, Goodwin R, Korohina E, Funaki-Tahifote M, et al. Cost and affordability of diets modelled on current eating patterns and on dietary guidelines, for New Zealand total population, Māori and Pacific households. Int J Environ Res Public Health. 2018;15(6):1255. https://doi.org/10.3390/ijerph15061255

[17] Lee AJ, Kane S, Ramsey R, Good E, Dick M. Testing the price and affordability of healthy and current (unhealthy) diets and the potential impacts of policy change in Australia. BMC Public Health. 2016;16(1):315. https://doi.org/10.1186/s12889-016-2996-y

The proportion of energy provided by each food is different in the healthy diets than in current diets. Food groups with lower cost per energy unit represented a higher proportion of the total cost of the CDs compared to HDs, such as non core foods (24% vs. 5%). Inversely, more expensive food groups per energy unit represented a much higher proportion of the total product basket cost for the HDs than the CDs, such as fruit and non-starchy vegetables (34% vs. 12%) (Figure 2).
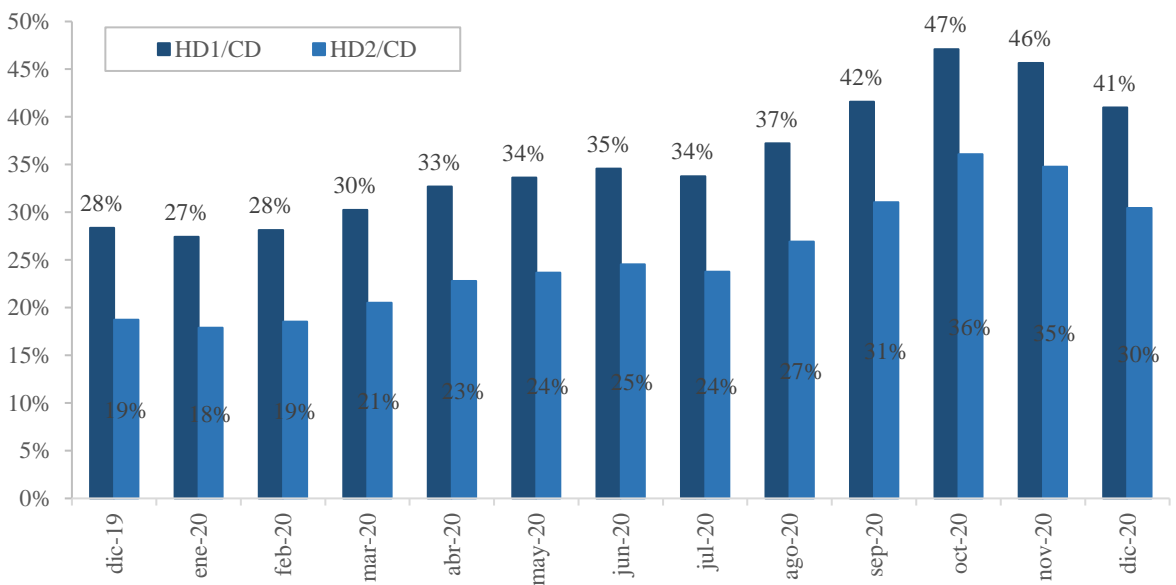
Figure 2: Composition of diet costs by food group products. April 2020. Greater Buenos Aires

Source: Own estimation.

Healthy diets were more expensive than current diets during all 2020. In the anual comparison, from December 2019 to December 2020, the gap between HD1 and CD increased from 28% to 41%. Price increase due to the inflationary process in Argentina and seasonal components of some products - particularly fruits and vegetables- may have affected the evolution of food prices. For instance, during October 2020 the gap on the cost increased to 47% between CD and HD1 and 36% between CD and HD2.
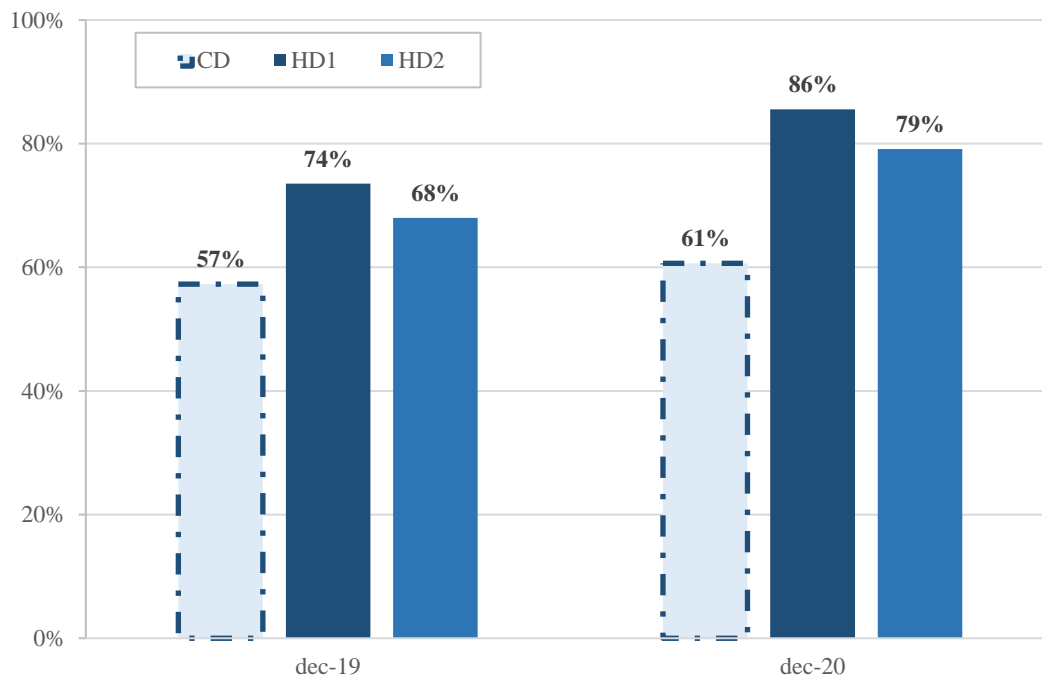
Figure 3: Gaps between diets cost. December 2019-December 2020. Greater Buenos Aires

Source: own estimation.

Healthy diets remained less affordable than current diets during all of 2020. Over 60% of households would have been unable to afford the modelled healthy diets in both periods. The CD was 4 percentage points less affordable in December 2020 than in the same period of 2019, while both HD 1 and HD 2 were between 11 and 12 percentage points less affordable in December 2020.

Figure 4: Diets affordability. December 2019-December 2020. Greater Buenos Aires

Source: Own estimations.

Policy implications

This study shows how limitations in the availability of price data to calculate the costs of different diets or consumption baskets can be overcome by the use of national big data sources -like the Precios Claros database- and big data tools. Most studies analyzing food prices use data from the Consumer Price Index Survey and/or Household Expenditure Surveys, and these are usually focused on a limited number of food items (such as most consumed products). Datasets with such a low variety of foods may result in inaccurate estimates of the cost of obtaining a healthy diet. Leveraging the availability of underexploited data sources like Precios Claros can be an invaluable resource to inform the governments (national and sub-national) on the state of people's real access to healthy foods in terms of affordability, and at the same time highlights the importance of keeping these databases secure, running and up to date.

Overall, knowledge on the cost and affordability gaps between current and healthy diets is an extremely important tool to inform the design of effective public policies to reduce obesity and NCDs in Argentina. Based on the study results, we claim that it is necessary to implement urgent measures to transform the obesogenic environment, making healthier products more affordable, available, and desirable, and discouraging consumption of nutrient-poor, energy-rich foods.

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