REVIEW

Obesity Among Peruvian Children Under Five Years of Age in 2017: a Geographic Information System Analysis

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ABSTRACT

Introduction: The Sustainable Development Goal (SDG) number 2 aims to end malnutrition in all its forms. To reach this goal one of the several health problems to tackle is childhood obesity. **Aim:** In this study, spatial data for the prevalence of obesity among Peruvian children under five years of age in 2017 is presented and analyzed in order to observe in which regions this disease is a high risk. **Material and Methods:** By geo-referencing public data provided by the National Institute of Health from Peru and using a Geographic Information System (GIS) tool, it was possible to generate maps of prevalences and also of clusters and outliers at a regional and district level, respectively. **Results:** Observing at the map of prevalences, it could be identified that in the natural region of the coast there are the highest prevalences of obesity among children under five. A second map showing the hot spots and the outliers is also presented. This second map is very revealing because it shows the districts which are classified as outliers and thus in danger of becoming hot spots for childhood obesity in the future if no action is taken. **Conclusion:** In view of the spatial distribution of hot spots and outliers of obesity among children under five years of age, it is recommended that health governmental and non-governmental entities from Peru allocate their resources where is urgently needed in order to attempt to reduce childhood obesity, and helping in reaching as well SDG 2.

Keywords: Geographic Information Systems, Obesity, Child, Maps

1. INTRODUCTION

On September 25, 2015, the United Nations (UN) General Assembly agreed on 17 sustainable development goals (SDGs) for a better future. Goal number 2 not only aims to end hunger but also aims to end malnutrition in all its forms (1). One of the burdens of malnutrition is obesity, which is simply defined as having excess of fat in the body (2). It has been indicated that in North America and some countries in Europe, obesity in children has the highest prevalence (3, 4). On the other hand, in some developing countries obesity is also on the rise. In South America, the prevalence of childhood obesity in Brazil and Argentina is of 22.0% and 19.3%, respectively (5).

During the 35th Regional Conference for Latin America and the Caribbean, organized by the Food and Agriculture Organization of the UN and held in March 2018, it was reported that Peru occupies the third place in the region with the highest prevalence of obesity and overweight (6). Using data from the National Institute of Health (in Spanish: Instituto Nacional de Salud–INS) from Peru, two recent studies (7, 8) have shown that the prevalence of obesity in Peruvian children under five years of age has slightly decreased from 2.42% in 2014 to 1.52% in 2015. As indicated by the World Health Organization (WHO) children affected by overweight and obesity can develop, for example, diabetes and/or cardiovascular diseases (9). Furthermore, they can develop mental disorders like depression (10, 11).

Geographic Information Systems (GIS) is a tool that allows to identify health trends and allocate health services where needed (12). For instance, a recent study (13) has proven to improve the strategies against malaria in Uganda using GIS along with smartphone technologies. In regards to obesity and overweight studies, a recent review had found out in the search engine PubMed approximately 121 works

Figure 1. Prevalence of obesity in children under 5 years of age in Peru during the year 2017

in English that use in some way GIS (14). In this paper, the current state of obesity in Peru is looked into by presenting the spatial distribution of the prevalence of obesity across the country for the year 2017.

2. AIM

In this paper, the current state of obesity in Peru is looked into, by presenting the spatial distribution of the prevalence of obesity across the country for the year 2017.

3. MATERIAL AND METHODS

Data for the prevalence of obesity in Peruvian children under five years of age during the year 2017 is available to the public via the system for information about the nutritional state provided by the INS (http://www.portal.ins.gob. pe/es/). This system gathers, organizes and reports about the nutritional state of Peruvian children under five years of age and pregnant women who are treated in health facilities (in Spanish: Establecimiento de Salud–EESS) across Peru.

Maps of Peru at a region (Peru is made up of 25 administrative regions) and district level are available as shape files in the database of global administrative areas (GADM, https:// gadm.org/download_country_v3.html). Due to the absence of the Titicaca Lake, a shape file for the major lakes worldwide from the University of California, Los Angeles (UCLA) geoportal (https://gis.ucla.edu/geodata/dataset/world_lake) was downloaded.

Data provided by the INS come as Microsoft Excel spreadsheets. Because these data is non-georeferenced an with a bit of a cumbersome header structure, some pre-processing before importing the INS data into the ArcGIS version 10.5 software (developed by Environmental Systems Research
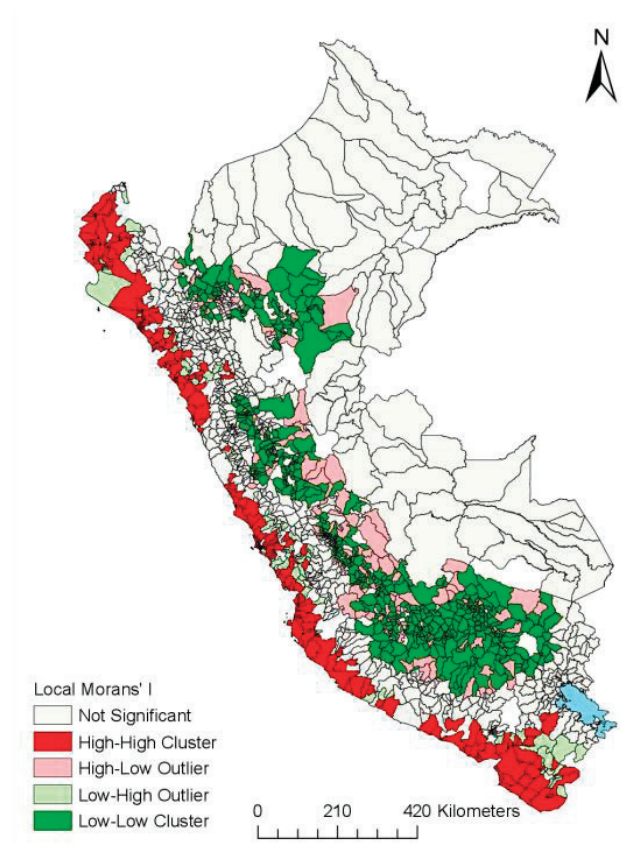

Figure 2. Geographic distribution of clusters (red and green) and outliers (pink and light green) of obesity among peruvian chilren under 5 years of age across Peru in 2017.

Institute–ESRI) had to be carried out. Additionally, some names of the regions and districts are all written in capital letters, while the ones in the attribute tables of the shape files of GADM have only the first character as capital and the rest as non-capital. Hence, the Pandas (https://pandas.pydata. org/) library from the Python programing language was used to change the capital strings to non-capital ones using methods like *.str()* and *.title()*. Afterwards, comma-separated value (CSV) files, which ArcGIS can easily handle, were created. Once imported, the data at a region and district level was incorporated into the attribute tables of the shape files from GADM. To perform the aforementioned task, the ``Join Data'' method of ArcGIS was used. At the department level all 25 regions were matched with data from the INS; however, at a district level only 1638 out of 1815 records were matched. Even tough this is not a complete match for all districts from the GADM shape file, which for example might be due a different name in the tables, for the purpose of this study is a significant amount.

In order to identify clustering or outliers of obesity among Peruvian children under five at a district level in Peru, we used the Local Moran's Index (Moran's I).

4. RESULTS

In Figure 1, it can observed that the two regions with the highest prevalences of obesity among children under five years of age are the ones located in the southern coast of Peru: Moquegua with 3.0% and Tacna with 3.7%. This is an improvement with respect to what was observed in 2014: Moquegua and Tacna had prevalences of 4.3% and 5.0%, respectively (8). Following with moderate prevalences of obesity

among Peruvian children under five are the regions of Tumbes, Lambayeque, La Libertad, Lima, Callao and Ica. The aforementioned regions belong all to the traditional natural region of the Peruvian coast. It is here in the coast where most of the urban areas of Peru are located. This, agrees well with what has been indicated by a past study (15): that urbanization may be the cause for childhood obesity due to the changes in their diet (e.g., food high in fat and sugars) and also due to less physical activity.

Figure 2 shows the spatial distribution of the hot spots, cold spots and outliers of obesity in children under five years of age according to the local Moran's I. As already observed in Figure 1 the hot spots or clusters of obesity are strikingly located in the administrative regions of the coast. On the other hand, nearly all the cold spots of obesity among Peruvian children under five are located in the natural region of the highlands. The regions that are located in the highlands are: Cajamarca, Ancash, Huanuco, Pasco, Junin, Huancavelica, Ayacucho, Apurimac, Cusco, Arequipa and Puno. This concentration of cold spots, especially in the southern part of the Peruvian highlands, agrees well with the southern regions of the highlands that have the lowest prevalences of obesity among children under five years of age: Junin, Ayacuho, Apurimac and Cusco. In Figure 3, it can be seen in detail the southern and central coastal regions. In the map of the southern coastal regions it can be noticed that Tacna and Moquegua have 14 and 12 districts were childhood obesity can be considered as a high risk. Additionally, Tacna and Moquegua also present 9 and 3 outliers (districts in light green), respectively. On the other hand, in the regions of the central coast, Lima and Callao, it can be found the highest number of districts considered as hot spots, a total of 66 districts.

5. DISCUSSION

The outliers observed in Figure 3 are of utmost importance because they are in danger of becoming hot spots in the future if no action is taken. Not only in the central and southern coastal regions of Peru outliers are observed, but also in the northern coastal regions (Figure 2). Thus, it is crucial that governmental entities like the Ministry of Health from Peru, for instance, allocate better their resources to try to reduce these outliers along the natural region of the coast before they increase in number. Also it is urgent that hot spots are directly targeted in this natural region. The Pan American Health Organization proposes for example a plan of action that involves healthier eating, increase of physical activity and also regulation of the food marketing, in order to reduce childhood obesity (16).

6. CONCLUSIONS

To end malnutrition in all its form is part of the sustainable development goal number 2. However, in order to attain this goal, several health problems need to be tackled. Obesity among children under five years of age is one of them. In Peru it was observed that for the year 2017, the highest prevalences of the Peruvian children that are affected by it are located in
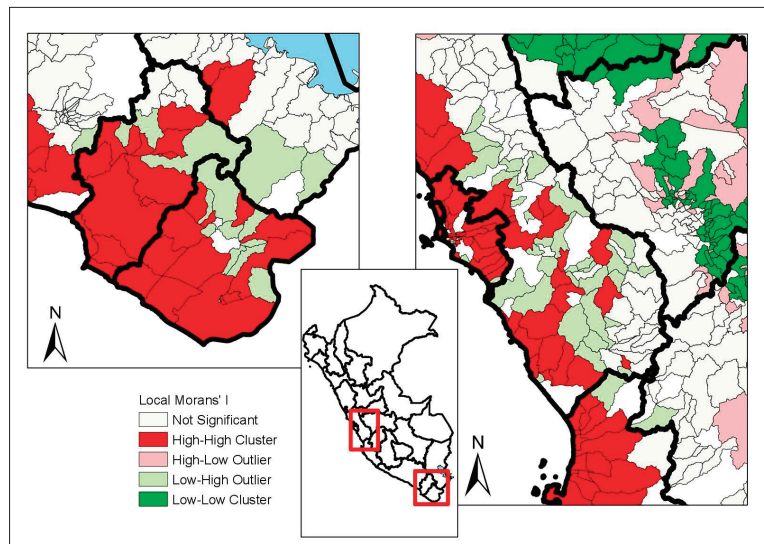

Figure 2. Geographic distribution of clusters (red and green) and outliers (pink and light green) of obesity among peruvian chilren under 5 years of age across Peru in 2017.

the natural region of the coast. Moreover, by using local Moran's I, it could be observed clearly where the hot spots for this disease are located. Not only hot spots could be identified but also cold ones and outliers. It is thus hoped that this study using GIS technology serves the health governmental entities of Peru to allocate better their resources and services, and hence fight against the increment of the prevalence of obesity among Peruvian children under five years of age in the hot spots and outliers presented in this paper.

REFERENCES

1. United Nations General Assembly. Transforming our world: the 2030 Agenda for Sustainable Development. [cited 2018 Jul 28]. Available from: https://www.imperial.ac.uk/media/imperial-college/administration-and-support-services/library/public/vancouver.pdf

2. Center for Disease Control and Prevention. Childhood Obesity Facts. [cited 2018 Aug 2]. Available from: https://www.cdc.gov/healthyschools/obesity/facts.htm

3. Chaput J.-P., Tremblay A. Encyclopedia on Early Childhood Development -- Obesity at an Early Age and Its Impact on Child Development. [cited 2018 Aug 1]. Available from: http://www.child-encyclopedia.com/child-obesity/according-experts/obesity-early-age-and-its-impact-child-development

4. Wang Y., Lim H. The global childhood obesity epidemic and the association between socio-economic status and childhood obesity. Int Rev Psychiatry. 2012; 24:176-188.

5. Gupta N., Goel K., Shah P., Misra A. Childhood Obesity in Developing Countries: Epidemiology, Determinants, and Prevention. Endocr Rev. 2012; 33:48-70.

6. Peru21. Peru es el pais de America donde la obesidad infantil crecio mas rapido. [cited 2018 Jul 28]. Available from: https://peru21.pe/peru/peru-pais-america-obesidad-infantil-crecio-rapido-informe-399856

7. Hernandez-Vasquez A., Bendezu-Quispe G., Santero M., Azanedo D. Prevalence of childhood obesity by sex and regions in Peru, 2015. Rev Esp Salud Publica. 2016; 90:e1-e10.

8. Hernandez-Vasquez A., Bendezu-Quispe G., Diaz-Seijas D., Santero M., Minckas N., Azanedo D., Antiporta D. A. Analisis espacial del sobrepeso y la obesidad infantil en el Peru, 2014. Rev Peru Med Exp Salud Publica. 2016; 33:489-497.

9. World Health Organization. Childhood overweight and obesity. [cited 2018 Jul 26]. Available from: http://www.who.int/dietphysicalactivity/childhood/en/

10. Morrison K. M., Shin S., Tarnopolsky M., Taylor V. H. Association of depression & health related quality of life with body composition in children and youth with obesity. J Affect Disord. 2015; 172:18-23.

11. Beck A. R. Psychosocial Aspects of Obesity. NASN Sch Nurse. 2016; 31:23-27.

12. McLafferty S. L. GIS and Health Care. Annu Rev of Public Health. 2003; 24:25-42.

13. Larocca A.,Visconti R. M., Marconi M. Malaria diagnosis and mapping with m-Health and geographic information systems (GIS): evidence from Uganda. Malar J. 2016; 15:520.

14. Jia P., Cheng X., Xue H., Wang Y. Applications of geographic information systems (GIS) data and methods in obesity-related research. Obes Rev. 2017; 18:400-411.

15. Pirgon O., Aslan N. The Role of Urbanization in Childhood Obesity. J Clin Res Pediatr Endocrinol. 2015; 7:163-167.

16. Pan American Healh Organization. Plan of Action for the Prevention of Obesity in Children and Adolescents. [cited 2018 Aug 2]. Available from: https://www.paho.org/hq/dmdocuments/2015/Obesity-Plan-Of-Action-Child-Eng-2015.pdf?ua=1