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Impact of Natural Disaster on Health of Children: Empirical Evidence from Nepal's Earthquake

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Abstract

This study estimates the impact of the 2015 Nepal earthquake on the health of children: weight, height, and Body Mass Index (BMI). It uses two rounds of data related to Nepal Demographic Health Surveys (NDHS) before and after the earthquake, i.e., in 2011 and 2016. The study combines child-related information and household-level data from NDHS with the earthquake data available at the district level to identify the impact of the earthquake on children's health. By focusing on children between 0 to 5 years of age and using the difference-in-difference framework as an identification strategy, results show that the BMI increased for children living in affected areas. This increase in BMI is primarily driven by an increase in their weight. The study further shows that the BMI of children increases in earthquake-affected areas because of the increased food consumption. The study underscores the importance of being selective in the type of food-aid distributed as well as changing the consumption behavior of children during the post-disaster periods.

Keywords: *Natural disaster, Earthquake, Body mass index, Diff-in-diff, Nepal.*

JEL Classification: *I10, I12, I18, Q54*

Introduction

Natural disasters usually have a significant impact on the mental and physical health of children. It can impact physical health through several channels, ranging from the reduction in calorie intake, essential vitamins, and nutrients to unhygienic conditions and lack of safe drinking water (Kousky, 2016). The former has an impact on the physical growth of children, while the latter can cause water-borne diseases such as diarrhea, cholera, and other intestinal diseases. Natural disasters can also destroy health infrastructure, which could further deteriorate health outcomes.

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It is also evident that childhood obesity has reached epidemic levels in developed as well as in developing countries. Data shows that almost half of all overweight children under five years live in Asia and Africa. Overweight and obesity in childhood have a significant impact on both physical and mental health. These children are most likely to develop diabetes and cardiovascular diseases at a younger age (Bhadoria et al., 2015).

CIA World Fact Book - 2016 shows that the prevalence of obesity in Nepal is 4.1 percent among the adult population. One of the major causes of obesity identified worldwide is the sedentary lifestyle and fat- and sugar-laden diets (Vaidya et al., 2010). Moreover, the Nepalese diet has shifted from agricultural staple foods to modern processed foods with higher energy, fat, and sugar (Subedi et al., 2017). Children under two in Nepal get a quarter of their calories from junk foods that usually have high sugar, salt, and fat content (Pries et al., 2016). The consumption of junk food not only has a bearing on the obesity epidemic, but young children may also suffer from undernutrition.

Several studies have indicated the problem of access to nutritious food in post-disaster periods, particularly among children (Ainehvand et al., 2019). At such times, people usually run out of food and, therefore, do not care much about nutrition and may consider always eating junk foods such as noodles and biscuits. This may restrict the consumption of dietary and nutritious food, which is a matter of significant concern to vulnerable groups, including children (Tsuboyama-Kasaoka & Purba, 2014). Hence, consuming high-calorie but less nutritious food would increase the energy intake, which may increase weight (See Figure 1 below).

Nepal experienced a 7.8 richter scale earthquake on 25th April 2015. After the Nepal's earthquake, many households in affected areas were dependent upon food aid from various government and non-governmental agencies for a prolonged number of days. Numerous aftershocks restricted the movement of people, which increased their dependency on food aid with less nutrition but high-calorie content, such as flattened rice, noodles, and biscuits (CDPS, 2016; Raut, 2021). As mentioned earlier, such food items have the effect of increasing weight. It is, therefore, important to examine whether Nepal's earthquake also had an impact on the weight of under-5 children, and while further establishing the channels, examining whether the earthquake increased the consumption of staple or fatty foods that may partly help to explain the relationship between the phenomenon of the earthquake and weight of children. This study estimates the causal effect of Nepal's earthquake on children's health, including weight, height, and BMI.[3] It uses the two rounds of Nepal Demographic Health Surveys

3 BMI is defined as the body mass divided by the square of the body height and is expressed in kg/m^2. BMI less than 18.5 is categorized as underweight; between 18.5 and 24.9 as normal; between 25 and 29.9 as overweight and 30 or greater than 30 as obesity (https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle-who-recommendations). For children

(NDHS) before and after the earthquake, i.e., in 2011 and 2016. The earthquake data available at the district level is combined with the NDHS data to establish the causal association between the earthquake and the health of children. The focus is on children between 0 and 5 years old. A *difference-in-difference* (diff-in-diff) framework as an identification strategy is used where the variation in earthquake intensity at district levels is utilized as a source of identification. Results show that the weight of children in affected areas increases while there is no significant effect on their heights. Accordingly, the result shows that the BMI increased for children living in affected areas, which seems to be largely driven by increased weight.

The study also explores the possible mechanisms of this positive association between the earthquake and the increase in BMI. Annual Household Survey (AHS) data for 2013-14 and 2016-17 are used for this. The AHS has sufficient details about the expenditure on food consumption and their allocation in various food items. It is hypothesized that the change in consumption patterns will drive any changes in the BMI of children due to earthquakes. The study reveals that expenditure allocation in food items increased in earthquake-affected areas. The study does not find support for the hypothesis that staple / fatty food consumption increased only in affected areas. The time used before and after the earthquake cannot be observed from the available data. Hence, the study cannot conclude whether the earthquake-affected households worked less and spent more time doing nothing.

The study is organized as follows. Section 1 briefly introduces the study. Section 2 presents the conceptual framework of the study. Section 3 reviews the literature and identifies the existing gap in the literature. Section 4 describes data and methodology, while section 5 describes the data analysis and results. Section 6 presents the mechanisms, discussion, and robustness. Finally, section 7 concludes the study.

Conceptual Framework

The conceptual framework (Figure 1) indicates two possible channels explaining how Nepal's earthquake may have affected the weight of children. The first channel shows that the labor market contracted in the immediate aftermath of the earthquake, which reduced the income of the households (Quisumbing & Mueller, 2011). Similarly, the shortage of food supplies also increased the price of high-calorie foods, both nutritious and less nutritious (Bellemare, 2015). The

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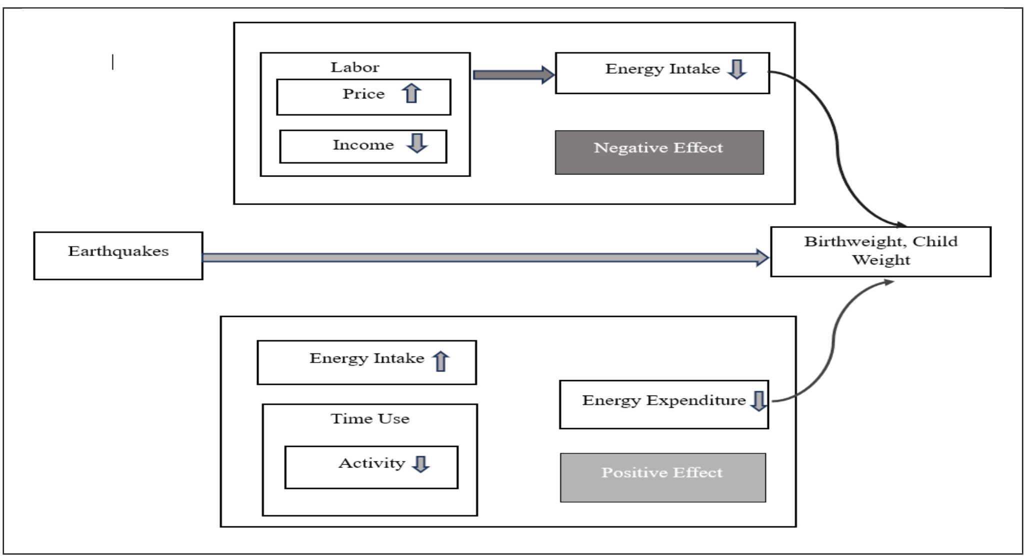
and adolescents, underweight is children with less than 5th percentile BMI, normal is children between 5th and 95th percentile BMI, overweight is children between 85th and 95th percentile BMI, and obesity is children with more than 95th percentile BMI (https://www.utmb.edu/pedi_ed/Obesity/page_04.htm#:~:text = For % 20 Children%20and%20 Adolescents%3A, th%25%20and%20%3C95%20th%25).

combined effects of the fall in income and increase in prices may have reduced households' energy intake, thus causing the children's weight to decrease.

The second channel shows that, because of the fall in income and increase in food prices, there may also be substitution from low-calorie nutritious (high-priced) food to high-calorie, less nutritious (low-priced) food. The affected households may also receive food aid that primarily includes high-calorie but less nutritious food like noodles, biscuits, flattened rice, coarse rice etc. This will increase the calorie intake of the children. The earthquake-affected households may also restrict outdoor playing of the children and some households may not send their children to school for safety reasons (Kinoshita & Woolley, 2015). This will also restrict their physical activity. Hence, an increase in calorie intake and restricted physical activity may have an effect of increasing the weight of the children.

Figure 1: Conceptual Framework



Source: Author's illustration.

In this study, only limited channels are tested due to the unavailability of data. In particular, it is not tested whether the earthquake restricted the physical activity of the children or not. The mechanisms are discussed in detail in Section 7.

Review of Literature

Several studies focus on the effect of natural disasters on infant and child mortality, mental health, and the prevalence of water-borne diseases. Few studies investigate the effect on physical health and child obesity in particular. Many literatures look into the effects of prenatal maternal exposure to natural disasters on the growth of children. The majority of them conclude that prenatal stress increases BMI and adiposity (Dancause et al., 2012; Dancause et al., 2015).

Literature that compares the physical growth outcomes between the children in affected and unaffected areas increased particularly after the Great East Japan Earthquake in 2011[4]. Ono et al. (2018) explained that the major reasons for the studies undertaken were that there were reported cases of obesity among the adults and overweight among the nursery children over three years in the affected areas. Ohira et al. (2016) compare the body weight and the proportion of overweight/obese people among the evacuees and non-evacuees. The mandatory evacuation was ordered by the government for the residents living in a high radioactive concentration area in Fukushima, where the Nuclear Power Plan (NPP) accident occurred. The study found that the body weight and the proportion of overweight/obese people increased significantly among evacuees than non-evacuees. The study argues that the change in lifestyle among many evacuees may have led to the different weight outcomes.

Other related studies focus on the BMI of preschool children (Yamamura, 2016; Moriyama et al., 2018a; Isojima et al., 2017; Zheng et al., 2017). Most of these studies either uses longitudinal or retrospective longitudinal data, categorizes children as affected (children of specific birth cohort exposed to the disaster: Earthquake / tsunami / NPP) and unaffected (children of specific birth cohort not exposed to the disaster), and measure the differences in their BMI before and after the disaster. These studies conclude that the exposed children normally had higher BMI and obesity prevalence as compared to the children not exposed to the disaster. Only a few studies focus on physical growth in early childhood (0-3 years) with similar conclusions (Ono et al., 2018; Yokomichi et al., 2018). Although most of these studies utilize longitudinal data, they compare the growth outcomes between the affected and unaffected children before and after the disaster without using robust statistical/econometric methods for causal analysis. Only one among these studies uses the 'diff-in-diff' framework to analyze the effects of the NPP on obesity in children (Yamamura, 2016).

Limited studies have been done in the region investigating the causal association between natural disasters and the health of children. This is even though South Asia is one of the most vulnerable regions in terms of the frequency of occurrence of natural disasters, the proportion of the population exposed to natural disasters, and the resulting value of damages (World Bank 2012; Kafle, 2017). Moreover, children bear the brunt of natural disasters, most of all physical, mental, social, and emotional often resulting in poor health, labor, and educational outcomes (Peek, 2008).

4 The Great East Japan Earthquake was construed as one of the biggest natural disaster in the recent times that resulted into three forms of disaster namely, an earthquake, a tsunami, and the Fukushima Daiichi Nuclear Power Plant accident ('Lessons of a Triple Disaster' 2012; Ochi et al., 2013).

Scant evidence is available in the region that analyzes the effect of natural disasters on the obesity of children. Available studies on physical growth / health focus primarily on child stunting, a measure of the nutritional imbalance that causes undernutrition among children of 0-59 months. For example, Datar et al. (2013) found that children in India exposed to natural disasters during early childhood (0-59 months) are more likely to be stunted, underweight, and suffer acute illness. On a similar note, Gaire et al. (2016) conclude that the flood negatively affects child stunting more than the epidemics in Nepal.

To the best of our knowledge, peer-reviewed literature investigating the impact on the obesity of children is very limited. One closely related study uses mixed-longitudinal data (repeated cross-section plus longitudinal data) to assess the association between earthquake and child wasting (weight-for-height).[5] The study quantitatively compares the proportion of wasted and stunted children before and after the earthquake in the affected areas only (Thorne-Lyman et al., 2018). Although this study finds that the proportion for both the measures of child growth increased after the earthquake, implying improved health conditions, it does account for the changes in those measures in unaffected areas. Hence this study, like the other studies discussed earlier, cannot establish the causal relationship between the variables of interest.

This study will add to the existing literature in the following ways. First, limited in the literature exists in the region particularly in the context of the increased frequency of natural disaster events in the region and the growing number of evidence that supports the hypotheses of the change in lifestyle among the population. Hence, it is hypothesized that the consumption pattern and the extent of physical activity may have changed after the earthquake, thus affecting the lifestyle (Figure 1). Second, unlike previous studies, BMI is focused as a measure of the health of children. It is expected that the energy intake among children may have increased after the earthquake. Third, and more importantly, there are few studies that investigate the causal effect of earthquakes on the health of children by exploiting a robust framework for identification. This study uses the unbiased 'diff-in-diff' estimator, which allows for both group-specific (affected and unaffected children) and time-specific effects (period before and after the earthquake) by comparing the time changes in the means for the treatment and control groups (Wooldridge, 2010).[6] Hence, our identification strategy is cleaner.

5 High weight-for-height implies being 'overweight' (Onis & Blössner, 2016).

6 We further discuss the strengths and limitations of the '*diff-in-diff*' method in section below.

Data and Methodology

Nature and Sources of Data

The study uses two different nationally representative household surveys. The Nepal Demographic Health Survey (NDHS) is employed to establish the causal association between earthquakes and child health, while the Annual Household Survey (AHS) is used to establish the channel to such association. Two waves of 'Nepal Demographic Health Survey: NDHS 2011 and 2016' are used for the main estimation. It is a nationally representative household survey data on population, health, HIV, and nutrition administered in over 90 countries. On the health front, the survey collects comprehensive data on maternal and child health, including child nutrition. Unlike NDHS-2011, NDHS-2016 is based on updated urban-rural classification brought about by the structural changes made in 2017, where the number of municipalities increased significantly. Similarly, the number of districts also increased from 75 to 77. Since the additional two districts were part of two old districts, they were treated according to the old administrative structure.

Two-stage stratified random sampling is used for rural strata; while three-stage stratified random sampling is used for urban strata.[7] A total of 11,040 households were surveyed, where 12,682 women aged 15-49 in all households and 4,063 men in half of the surveyed households were interviewed. NDHS - 2011, on the other hand, is collected from 10,826 households, with 12,674 women aged 15-49 in all selected households; while 4,121 men aged 15- 49 were interviewed in half of the selected households. Samples were selected using two-stage stratified random sampling. Firstly, rural and urban enumeration areas were selected randomly from each domain, and secondly, households were selected from each enumeration area (EAs) (35 households in urban EAs and 40 households in rural EAs).

This study selected children aged 0 to 59 months in both surveys to assess their health status. A total of 1950 children were located in NDHS-2011, while 1996 children could be identified in NDHS-2016. Table 1 summarizes these children's statistics by affected and unaffected districts before and after the earthquake.[8] The number of observations is lower in affected areas because only a few districts were affected by the earthquake vis-à-vis the unaffected districts.

Table 1 show that the children's height has almost remained the same in affected areas before and after the earthquake. In unaffected areas, height increased by nearly 1 cm. Likewise, weight has increased in both areas, but the

7 In rural strata, wards are selected as primary sampling units (PSUs) and households are selected from each of these PSUs. In urban strata, one enumeration area is further selected from each PSU before the selections of households are made.

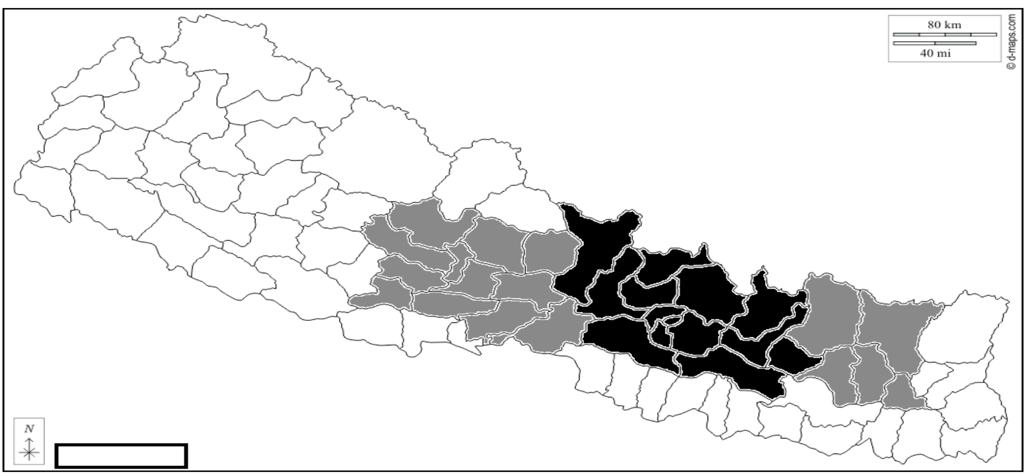
8 Since we exclude the districts that were moderately affected by the earthquake, the number of children used for econometric analysis that become smaller.

increase in affected areas is greater than in unaffected areas. BMI statistics show that BMI in affected areas has increased and decreased in unaffected areas. The health statistics reveal that the children's BMI may have been severely affected in the earthquake affected area.

Age is taken monthly from 0 to 59, which is asked at an interview. The ages of the children in the affected areas are higher by 1 to 2 months than those in unaffected areas. It has not changed much before and after the earthquake. Sex is used as '1' if an individual is a male. Most children are male than female in both the affected and unaffected areas. The gender composition has also not changed significantly before and after the earthquake. The wealth index is from 1 to 5, where '1' is the poorest and '5' is the richest. The wealth index is relatively improving in the unaffected area. It can be inferred from these statistics that there has not been a significant change in demographic characteristics in both the areas before and after the earthquake.

The study classifies 75 districts into affected, moderate, and unaffected districts according to the intensity of the effect of the earthquake. The data is taken from the United States Geological Society (USGS). According to this classification, Figure 1 shows that 14 districts are classified as affected districts (black color) in the map, 17 districts as moderately affected districts (gray color), and the remaining 44 districts are classified as unaffected districts (white color). However, moderately affected districts are not included in the analysis. Hence, the analysis only includes the sample of affected and unaffected districts.

Figure 1: Earthquake Affected Districts in Nepal



Source: United States Geological Society, 2015.

AHS data published by the Central Bureau of Statistics is used to investigate the channels that link earthquakes to child health, primarily the' calorie intake' channel. It is yearly repeated cross-sectional data from 2013-2014 to 2016-2017. It primarily collects information about the consumption and food expenditure patterns of Nepalese households. This study exploits all four rounds of AHS and selects those households with children under 5. The first two rounds of AHS-2013/14 and AHS-2014/15 were collected before the earthquake, while the other two rounds of AHS-2015/16 and AHS-2016/17, were collected after the earthquake. The descriptive statistics of the expenditure allocation made on various food items in the channel section will be presented and discussed in Table 5.

Table 1: Summary Statistics of Children Aged 0 - 59 Months

Variables	Mean Value of Unaffected Before	*Stand. Dev^n.	Mean Value of Unaffected After	*Stan. Dev^n.	Mean Value of Affected Before	*Stand Dev^n.	Mean Value of Affected After	*Stand Dev^n.
Dependent Variables								
Weight (in Kgs.)	10.43	3.82	10.56	3.10	11.10	3.26	11.35	3.20
Height (in cms.)	82.27	12.95	83.23	13.27	84.48	12.68	84.23	12.80
BMI in Kg/m^2	15.11	1.47	15.05	1.47	15.24	1.55	15.71	1.60
Independent Variables								
Age of the child	29.72	72.12	29.41	17.21	31.78	17.18	29.96	17.32
Sex of the child	0.52	0.50	0.52	0.50	0.52	0.50	0.48	0.50
Wealth Index	2.56	1.38	2.69	1.29	2.76	1.50	2.79	1.57
Ecological Zone								
Mountain	0.15	0.36	0.08	0.28	0.38	0.49	0.13	0.33
Hill	0.34	0.47	0.29	0.45	0.62	0.49	0.88	0.33
Terai	0.51	0.50	0.63	0.45	0.00	0.00	0.00	0.00
Development Region								
Eastern	0.22	0.41	0.20	0.40	0.05	0.22	0.04	0.20
Central	0.12	0.32	0.22	0.42	0.90	0.29	0.91	0.28
Western	0.08	0.26	0.09	0.29	0.05	0.21	0.04	0.20
Mid- western	0.32	0.47	0.30	0.46	0.00	0.00	0.00	0.00
Far Western	0.26	0.44	0.18	0.39	0.00	0.00	0.00	0.00
No. of Observation	1668	----	1764	----	282	----	232	----

Source: Calculated using Nepal Demographic Health Survey, 2011 & 2016.
Note: * Standard Deviation.

Empirical Strategy

The 'diff-in-diff' strategy is used to identify the impact of the earthquake on the BMI of children, which is expressed as follows:

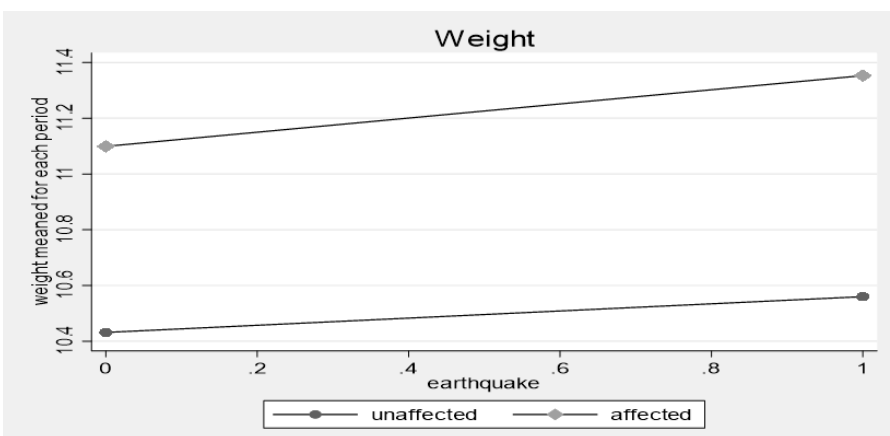
$$y_{idt} = \beta_0 + \beta_1(affected_{id} * after_t) + \beta_2(affected_{id}) + \beta_3(after_t) + X_{idt} + \mu_d + \varepsilon_{idt} .. \quad (1)$$

Subscription 'i', 'd', and 't' indicate the child 'i' in the district 'd' interviewed in the year 't'. μ_d is district fixed effect. This is because the study uses repeated cross-section analysis combined with the district-fixed effect. The study uses weight, height, and BMI as dependent variables (y_{idt}). $affected_{id}$ is a dummy variable equal to 1 for the districts affected by earthquake and 0 otherwise. $after_t$ is a dummy variable equal to 1 for the observation from the survey year after the earthquake and 0 for the pre-earthquake observations. The interaction term of these variables is $affected_{id} * after_t$ which is known as the 'diff-in-diff' estimator. The estimate of the coefficient β_1 yields the impact of the earthquake on dependent variables. Other control variables in X_{idt} are the sex and age of children, geographic, and region dummies. The wealth quintile of the household of the children is also controlled in the regression equation.

Data Analysis and Results

The study investigates the effects on weight, height, and BMI. This is important to tease out the key driver of the effect of the earthquake on a child's BMI. First, the effect of earthquakes on the weight of children is presented. Figure 2 shows that the children's weight increases in affected and unaffected areas. However, the slope of the line for affected areas is marginally steeper, indicating that the weight of the children in affected areas has increased more than that of the children in unaffected areas. Since the graph is not clear about the magnitude by which the increment is higher, the regression results are presented in Table 2, which not only shows the direction or sign of relationship between the earthquake and weight of children but also shows their causal association.

Figure 2: Change in Weight of Children in Affected and Unaffected Areas



Source: Nepal Demographic Health Surveys, 2011 & 2016.

Table 2: Regression Results for Weight of Children

Variables	**1**	**2**
	OLS (Standard Error)	**Fixed Effect (Standard Error)**
Affected* After (diff-in-diff)	0.318** (0.1510)	0.290*(0.1620)
After = (1 if observation is from the post-earthquake period)	0.184*** (0.0632)	0.209*** (0.0621)
Affected = (1 if household is from earthquake affected district)	0.357** (0.163)	-------
Age	0.158*** (0.00153)	0.158*** (0.0015)
Sex	0.515*** (0.0471)	0.522*** (0.0456)
Wealth Index = 2, Poorer	0.266*** (0.0842)	0.191** (0.0826)
Wealth Index = 3, Middle	0.479*** (0.0825)	0.405*** (0.0880)
Wealth Index = 4, Richer	0.719*** (0.1040)	0.666*** (0.1070)
Wealth Index = 5, Richest	1.229*** (0.1220)	1.135*** (0.1170)
Constant	5.018*** (0.1430)	5.105*** (0.0755)
No. of Observations	3,946	3,946
R-squared	0.791	0.793
Ecological Fixed Effect	Yes	No
Regional Fixed Effect	Yes	No
District Fixed Effect	No	Yes
No. of Districts	58	58

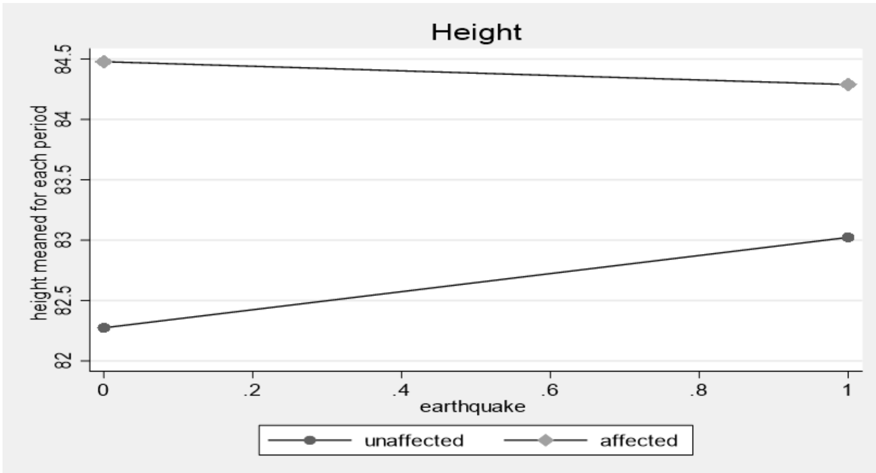
Source: Author's calculation.

Note: Robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Fixed effects consider inter-spatial unobserved heterogeneity at the given level while estimating the regression equation.

Table 2 shows that there is a positive effect of earthquake on the weight of children. The 'diff-in-diff' estimator, which shows the effects of earthquake among children in affected areas, is also positive and significant. Both OLS and Fixed Effect Models in columns 1 and 2 show that the weight of the children in earthquake affected areas increase by about 0.30 Kgs. vis-à-vis the children in unaffected areas. In the Fixed Effects Model, the coefficients for the affected variable are not reported since controlling for district fixed effects absorbs this variable. The age of children is positively associated with weight, indicating that weight increases nearly by 0.16 Kg when the child becomes one year older. Likewise, the weight of male children is likely greater by 0.52 Kg compared to the female children. The coefficient of wealth quintile shows that the weight of the children increases with the increase in wealth quintile; the weight of the richest quintile children is greater by 1.1 Kg as compared to the children in the poorest quintile.

Second, the effects of earthquakes on the height of children are explored. Figure 3 shows the effect of changes in the height of the children before and after the earthquake in affected and unaffected areas. The Figure 3 shows that the height has declined in affected areas but has increased in unaffected areas. This might indicate that affected children are likely to be stunted.

Figure 3: Change in Height of Children in Affected and Unaffected Areas



Source: Nepal Demographic Health Surveys, 2011 & 2016

Table 3: Regression Results for Height of Children

Variables	1	2
	OLS (Standard Error)	**Fixed Effect (Standard Error)**
Affected* After (diff-in-diff)	0.0660 (0.6210)	- 0.203 (0.5310)
After = (1 if observation is from the post-earthquake period)	0.862*** (0.2080)	0.896*** (0.2140)
Affected = (if household is from earthquake affected district)	0.965* (0.5510)	----
Age	0.701*** (0.0054)	0.700*** (0.0055)
Sex	1.375*** (0.1690)	1.356*** (0.1680)
Wealth Index = 2, Poorer	1.214*** (0.2960)	0.933*** (0.2930)
Wealth Index = 3, Middle	1.878*** (0.2840)	1.585*** (0.2890)
Wealth Index = 4, Richer	2.322*** (0.3180)	2.156*** (0.3290)
Wealth Index = 5, Richest	3.436*** (0.2820)	3.237*** (0.3330)
Constant	58.92*** (0.3900)	59.62*** (0.2530)
No. of Observations	3,946	3,946
R-squared	0.864	0.864
Ecological Fixed Effect	Yes	No
Regional Fixed Effect	Yes	No
District Fixed Effect	No	Yes
No. of Districts	58	58

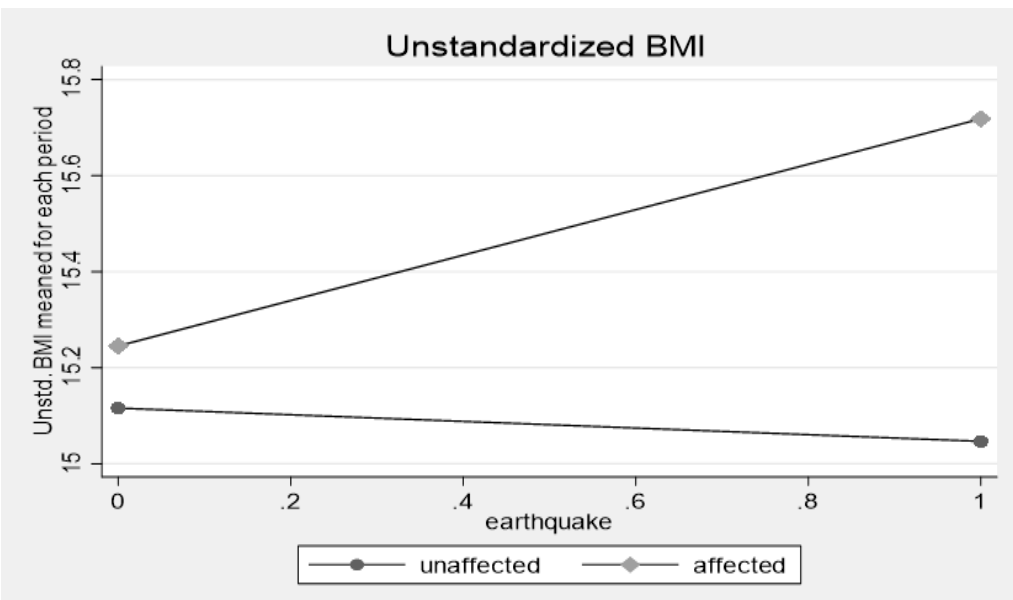
Source: Author's calculation.

Note: Robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Fixed effects consider inter-spatial unobserved heterogeneity at the given level while estimating the regression equation.

The regression results show that, although the height of children increases in general (time trend) after the earthquake, its effect on affected children is negative but statistically insignificant. It indicates that the earthquake affected the height of the children identically across both affected and unaffected areas. In other words, earthquakes have no particular effect on the height of children. Both OLS and Fixed Effect Models show similar results. The effects of other variables like age, sex, and wealth quintile on height are positive. An increase in age by a year would lead to an increase in height by 0.70 cm. The height of male children is bigger by 1.36 cm as compared to the height of the female children. Likewise, the height increases by wealth quintile. For example, the child in the richest quintile has a height of 3.24 cm. bigger than the child in the poorest quintile.

Lastly, the effects of earthquake on the BMI of children are examined. Figure 4 shows the temporal change in BMI among the children in affected and unaffected areas. It shows that the BMI of children in affected areas is increasing while that of those in unaffected area is decreasing. Table 4 shows the 'diff-in-diff' estimates for the effect of earthquake among children in affected areas. Both the OLS and the Fixed Effects Models estimation show that the BMI of children has increased in the range of 0.46 to 0.49. Since change in height remains largely unaffected due to earthquake, this increase in BMI is primarily driven by the increase in the weight of the children in affected areas. This indicates that the children have gained weight in the earthquake-affected areas.

Figure 4: Change in BMI of Children in Affected and Unaffected Areas



Source: Nepal Demographic Health Surveys, 2011 & 2016.

Table 4: Regression Results for BMI of Children

Variables	**1**	**2**
	OLS (Standard Error)	**Fixed Effect (Standard Error)**
Affected* After (diff-in-diff)	0.461** (0.1760)	0.496*** (0.1730)
After = (1 if observation is from the post-earthquake period).	- 0.0281 (0.0748)	0.00164 (0.0786)
Affected = (1 if household is from earthquake affected district).	0.140 (0.1950)	------
Age	- 0.0167*** (0.00150)	- 0.0163*** (0.0015)
Sex	0.268*** (0.0423)	0.283*** (0.0412)
Wealth Index = 2, Poorer	- 0.0578 (0.0774)	- 0.0818 (0.0716)
Wealth Index = 3, Middle	0.0559 (0.0853)	0.0394 (0.0830)
Wealth Index = 4, Richer	0.201* (0.106)	0.174* (0.0968)
Wealth Index = 5, Richest	0.427*** (0.1180)	0.361*** (0.1100)
Constant	15.47*** (0.1900)	15.37*** (0.0836)
Observations	3,946	3,946
R-squared	0.078	0.056
Ecological Fixed Effect	Yes	No
Regional Fixed Effect	Yes	No
District Fixed Effect	No	Yes
No. of Districts	58	58

Source: Author's calculation.

Note: Robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1. Fixed effects take inter-spatial unobserved heterogeneity at the given level into account while estimating the regression equation.

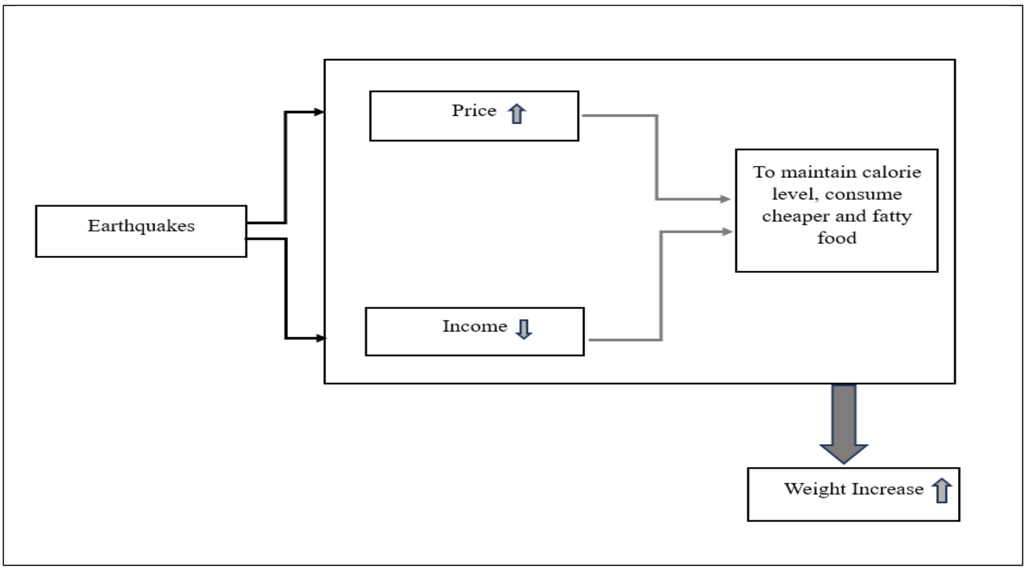
Age is negatively associated with BMI, while sex is positively associated with it. The latter suggests that the BMI of male children is higher by 0.28 as compared to that of female children. While the coefficients on the second and the third wealth quintile are not significant in explaining their effect on BMI, the children in the fourth and the fifth quintiles, respectively, have BMI 0.17 and 0.36 higher as compared to the children in the poorest quintile.

Mechanism, Discussion, and Robustness

Mechanisms

The earthquake may affect weight of children through three channels: changes in income change in the prices of food, and loss of workplace. If, for example, income falls, price of food increase and people lose work. This is expected to have a negative effect on household food consumption thus affecting their energy or calorie intake. However, the study cannot conclude about the effects on calorie intake whether it is positive or negative because, there is a possibility of substitution from the nutritious food to inferior foods which may contain high calories (like staple and junk foods which has more fat and sugar content) but less nutrients. This will have an effect of increased weight. Besides, it may also be possible that the households are reluctant to work or work extra hours which may then limit their physical activity. In that case, the households may spend less on food energy suggesting their energy expenditures are lower. Given that as the required data are not available to show the effects on time use of the household members, the study only tests the substitution hypotheses brought about by the changes in food prices and declining income as shown in given Figure 5.

Figure 5: Effects of Earthquake on Food Consumption of Households



Source: Author's illustration.

Similarly, the descriptive statistics using AHS data about the expenditure on food and non-food consumption is explored. Then, the amount of expenditure made on total food consumption of staple foods is presented. Table 5 shows that the households in affected areas increase their expenditure allocation on food items while the allocation in unaffected households remains the same. The change in expenditure made on staple foods for both affected and unaffected households is not observed, although these households spend a major proportion of their food expenditure on consumption of staple foods. This indicates that the increase in weight in the affected areas is not due to the increased consumption of cheaper staple foods.

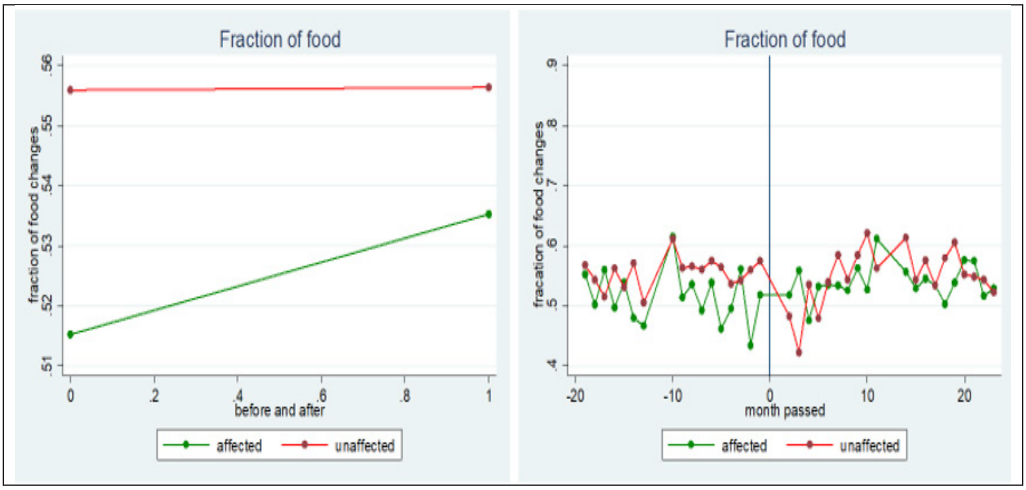
Table 5: Expenditure Allocation on Food and Non-food Items (Mean Value)

Description	Affected Area		Unaffected Area	
	Before	After	Before	After
Expenditure				
Total expenditure (NRs.in '000')	267.79	289.67	190.01	198.17
Food expenditure (NRs.in '000') (fraction of total expenditure)	124.11 (0.46)	139.23 (0.48)	98.14 (0.52)	102.86 (0.52)
Non-food expenses (NRs. in '000') (fraction of total expenditure)	143.68 (0.54)	150.44 (0.52)	91.90 (0.48)	95.30 (0.48)
Detailed Expenditure Breakdown				
Staple	0.17	0.17	0.18	0.18
Gram	0.05	0.06	0.05	0.06
Meat	0.20	0.20	0.19	0.18
Milk & Egg	0.07	0.06	0.04	0.04
Oil	0.09	0.08	0.09	0.10
Fruits	0.05	0.05	0.04	0.04
Vegetable	0.09	0.09	0.12	0.12
Spice	0.05	0.05	0.07	0.06
Sweet	0.05	0.05	0.05	0.05
Tea	0.01	0.01	0.01	0.01
Drink	0.01	0.01	0.01	0.01
Alcohol	0.02	0.03	0.03	0.03
Cigarette	0.03	0.03	0.03	0.04
Restaurant	0.12	0.11	0.08	0.07
Observations	1123	1160	1730	2206

Source: Calculated using Annual Household Survey, 2013-2014 to 2016-17.

Again, Figure 6 shows the change in the fraction of expenditure on food items before and after the earthquake. It is observed that the slope of the line for unaffected areas is flat, while it is positive for affected areas. Likewise, Figure 6 also shows that the pattern of food expenditure between affected and unaffected areas changes after the earthquake. In the months before the earthquake, expenditure allocation was higher in unaffected areas, while the pattern reversed after the earthquake. It means that the food expenditure allocation in affected areas increases in months after the earthquake i.e. food expenditure allocation increases by about 13 percent in the affected area while this is only 5 percent in the unaffected area. Hence, it is concluded that the earthquake increases household expenditure of affected households. This evidence also supports the weight of children analysis.

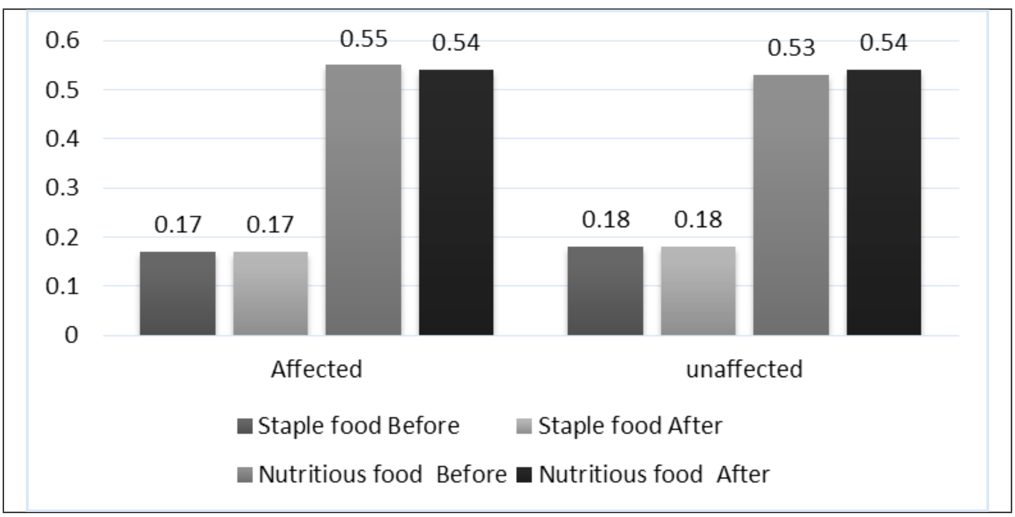
Figure 6: Fraction of Food Expenditure before and after the Earthquake



Source: Annual Household Survey, 2013-2014 to 2016-17.

Second, the study explores whether there is a substitution between nutritious and less nutritious foods like staples. It is observed in Table 5 that there is no change in expenditure made both on staple and nutritious food in both the affected and unaffected areas. Figure 8 also shows the same things. It can, therefore, be concluded that the substitution hypothesis is not correct and that the increase in weight is not due to the increased consumption of staple foods.

Figure 8: Composition in Consumption of Staple and Nutrition Foods



Source: Annual Household Survey, 2013-2014 to 2016-17.

To sum up, the study finds that the increase in weight in earthquake-affected areas is due to the increase in food expenditure, while it does not find evidence to support the hypothesis that this increase in weight is due to the increase in the consumption of staple foods.

Discussion

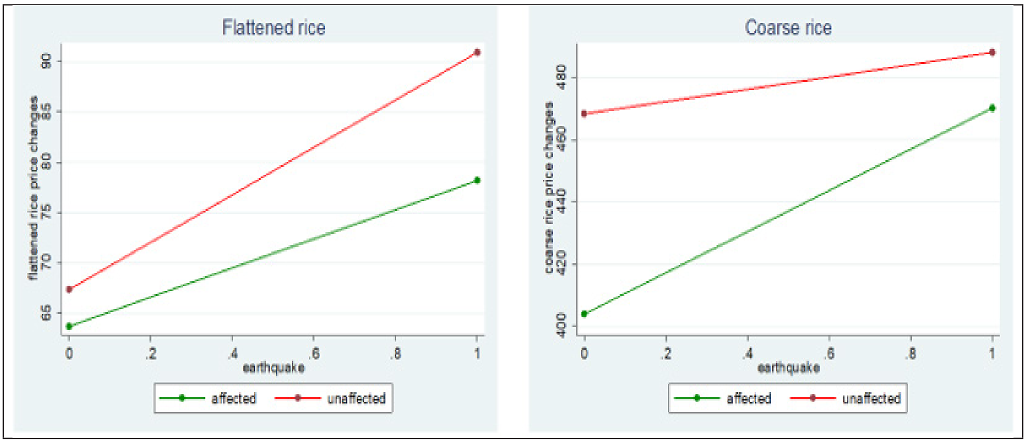
The basic premise of this study is that consumption habits and physical activity changes may have changed following the earthquake. This may have had disproportionate effects on vulnerable groups of women and children, in particular, their physical and mental well-being. The results show that while there is little to no change in the heights of children in the affected areas, their weights increase. Consequently, the BMI of children in affected regions also increases, which appears to be mostly driven by an increase in weight. Consistent with these results, Ono et al. (2018) found that children who were young gained weight after the 'Fukushima Prefecture Accident' occurred. Zheng et al. (2017) also showed that the Great East Japan earthquake affected preschoolers' longitudinal increases in BMI. They concluded that after the earthquake, more children in the exposed group had higher BMIs, and a larger percentage of children were overweight as compared to the children in the control group.

Studies like Yamamura (2016) give different perspectives of the reduction in BMI and also argued that the BMI of children living in Fukushima increased since they were compelled to cut back on physical activity. Similarly, after the Great East Japan Earthquake, one of the cities in Rikuzentaka was most devastated by obesity prevalence, but BMI increased in children in temporary housing compared with permanent housing (Moriyama et al., 2018). On the contrary, Yokomichi et al. (2018) found that Fukushima-affected babies and toddlers showed signs of development disruption and early adiposity rebound which can lead to obesity.

Robustness

It may be the case that the expenditure on food items may have increased due to the increase in prices in affected areas only. The study shows that the price of staple food items (i.e., flattened rice and coarse rice) increases in both the affected and unaffected areas of Nepal. Figure 7 shows that the price increase was observed nationally, which was not only concentrated in the areas affected by the earthquake. Households in the affected area tried to increase their food expenditure, but households in the unaffected area did not increase. As a result, child weight gain is greater in the affected area. Although information for food purchased quantity is available, each food has a different quantity unit, so it is difficult to compare between different categories.

Figure 7: Change in Price of Staple Food Items before and after the Earthquake



Source: Annual Household Survey, 2013-2014 to 2016-17.

Conclusion

This study found the positive effect of earthquakes on the BMI of children, resulting in weight gain of the children in the affected areas. The study explored the possible mechanisms of this positive association between the earthquake and BMI. For this, AHS data for 2013-14 to 2016-17 is exploited. The study shows that the expenditure allocation on food items increased in earthquake affected areas. The study further showed that this increase in expenditure was not due to the increase in prices in affected areas only. It is, therefore, argued that the BMI of children increased in earthquake-affected areas because of the increased food consumption. However, support for the hypothesis that this increase in consumption is primarily driven by the increase in the consumption of staple or junk food (with high-calorie content but less nutrition) cannot be established. Due to the lack of data about the time use of the children, it cannot be tested whether the physical activity (e.g., engaging in outdoor games and activities) of children was restricted after the earthquake for fear of its recurrence.

This study has important policy implications. Being overweight has a significant effect on the health of children both physical and mental. Given a shift in the Nepalese diet to modern processed food with high-calorie content, natural disaster adds to the severity of the problem. It may be necessary to be selective while distributing food aid to the affected households. Depending upon the emergency, high-calorie (less nutritious) food may be replaced by low-calorie (nutritious) after the natural disaster. Likewise, it may also be imperative to raise awareness among people of health consequences including problems of obesity and overweight, and also sensitize them to adopt healthy dietary habits during post-disaster periods.

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