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The Implications of Discriminant Analysis Function in Classifying the Obesity of Childhood < 15 in Egypt

"An Applied Study on the Data of EDHS 2015"

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Abstract

In general, relatively few statistical studies have been published on the classification of obesity as a risk-based thinking in the childhood stage among the children <15 years old in Egypt. Furthermore, the obesity is regarded as a critical risk that may impede the progress toward the desired level of human development due to its comorbidities and chronic diseases, particularly among children, which may persist with them from childhood to adulthood and elderhood without any tangible measures taken by the officials of state to effectively control the severity of this risk. For that reason, the research direction of this paper examines the impact of some key determinants available in the 2015 Egyptian Demographic Health Survey data (EDHS) to prove its statistically significant effected on the classification of the Egyptian child weight (obesity or non-obesity) based on exceeding the risk threshold 29.9 of the Body Mass Index (BMI) to classify as a confirmed obesity case. Thus, it should be focused on it by the planners to support the children of this selected age group (0-14) until they become adults in the adulthood stage.This study applied discriminant analysis to extract a statistical technique of classifying the status of children weight, thus a new discriminant function was derived and capable of classifying the BMI of Egyptian children <15 by 65% into two main groups: obesity or non-obesity based on seven variables represented, the age, educational level, years of schooling, gender, circumcision status, residency, breastfeeding, respectively according to the strength of the correlation coefficient of each variable in the proposed model. The recommendations of this study were divided into health & environmental, social, and economic work groups that may contribute to decision-making in order to ensure the sustainability of the Egyptian child's health through an ideal weight that will be allowed their effective contribution within the production wheel, progress and shaping the future for the next generations.

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1. Introduction

The world health organization (WHO) commission on ending childhood obesity stressed that governments and society have a moral responsibility to act on behalf of children to mitigate the risk of obesity (WHO, 2023). Obesity is defined as abnormal or excessive fat accumulation that presents a risk to human health based on measuring the body mass index

(BMI) and the broad term "overweight" refers to both overweight and its most severe manifestation: obesity. Childhood overweight is defined by the WHO as excess weight for height that is more than two standard deviations above the median indicated in child growth guidelines. It is also distinguished by an abnormally large amount of body fat (UNICEF, 2021). Obesity is defined by the WHO as an excess of body fat or adiposity that exceeds healthy limits and poses a health risk. Hence, the WHO indicated that when the BMI greater than 30, then it denotes clearly to become obesity case for anyone (Swinburn et al., 2019). Moreover, according to the International Classification of Diseases (ICD), obesity is a chronic, relapsing, complex condition. It is also a substantial risk factor for a variety of other noncommunicable diseases (NCDs), including diabetes, heart disease, and cancer. Obese children are more prone to chronic diseases than normal-weight children, as they are more likely to suffer adult-related health problems such as heart disease, diabetes, stroke, many types of cancer, and osteoarthritis (Zaky et al., 2019).

The obesity issue has increased significantly during pandemic COVID-19 and becomes be accompanied with many factors as significant risks which are affecting on the life of children to continue negatively in accordance with the health parameters that are accepted internationally of the body mass index BMI as well as the obesity rates are still in increasing continuously among the adults and children from 1975 to 2016 and until now (Jasim et al., 2020). The prevalence of obese children and adolescents aged 5–19 years increased more than four-fold from 4%-18% globally (www.who.int/health-topics/obesity). The obesity of childhood is considered as a serious non-communicable public health issue that could have negative consequences on the physical, social, and mental health within the communities (Hossein & Almarhomy, 2017). The emerging economies such as China, Brazil, and South Africa have great potential to prevalence of obesity among different strata of populations to all age groups (Daniel et al., 2000). The International Obesity Task Force declared that about 155 million of the world's children were obesity which their ages ranged from 5-17, including about 35- 40 million of which were severe obesity (WHO, 2018).

Once, the obesity was considered a health issue limited to the developed countries but has become on the rise gradually in developing countries, in particular the urban areas. On the top of that, most obese children are locating in the developing countries, where the obesity rates increase more than 30% higher than that of developed countries. Therefore, this study comes as trial seriously to assess the most important factors affecting on the classification of childhood obesity or non-obesity cases, by focusing on the children aged < 15 in Egypt as be considered a healthy risk affecting the children's abilities for becoming future-proof due to the potential lack in their positive contributions in continuous production process for the sustainable development effectively. Further, there are about 4.7 million cases of deaths occurred due to the risk obesity annually in the world level. As well as the cause of deaths back to the obesity ranked 5th compared to other causes of deaths. in addition to the WHO has indicated that Egypt ranking 18th and it is considered one of countries having the highest prevalence of obesity over the world.

On top of that, the discriminant analysis (DA) is one of statistical techniques that will be suitable to distinguish between specific categories under studying about any phenomena such as the obesity among children in the childhood stage due to it is being considered as a multivariate technique could be used in order to separate two or more categories of cases (populations) based on potential factors or (k)variables measured on each experimental group (sample) and find the contribution of each factor in separating between two or more groups. Upon the use DA, there are often hypotheses that strike the researcher that must be examined such as are their difference between the groups?', 'which variables have the most important impact?', and using such variables 'could one variable predict which the classification of a person belongs to specific group compared to other groups?'...etc. Consequently, the answer to such questions, it is better to use the discriminant analysis to support the discrimination between the groups determined by the researchers to be under the examination which is quite helpful (Abbas & Wasin, 2019).

Thence, the potential result of the current study comes to ensure the public interest in the most important determinants affecting statistically significant on the classification the Egyptian child weight whether obesity or non-obesity as serious step that urges all officials to focus on the important controls that limit the obesity prevalence risk among the children in the childhood (0-14) years old, as well as it could be supported for the efforts exert to increase their abilities when reach the adulthood to ensue actively contribute at the comprehensive development at good health, social, and psychological conditions be better. Thus, this study would be encouraged the work of re-improving these conditions to become suitable and doesn't hinder anyone from participating in the development process effectively. It is also an supporting the investment in the development of human capabilities and expanding their choices optimally for supporting more progress towards the ranking of human development level of Egypt, and for becoming Future-Proof towards the sustainable development as international priorities targeted for all governments as well.

2. The Proplem Of Study

Combating childhood obesity is consistent with the universal acceptance of children's rights to a healthy life, as well as the promises made by parties to the convention on the rights of the child. This international trend has the potential to increase pressure on authorities to address the numerous issues associated with the promotion of ultra-processed and unhealthy diets to children (UNICEF, 2021). Childhood obesity is becoming a significant public health concern in low-income countries where early prevention is crucial. Obesity incidence is rising fastest in emerging economies, where malnutrition is a double burden (World Obesity Federation, 2022). Much endeavors research published by the organizations or researchers about the Middle East area have sounded the alarm due to the prevalence of obesity rates because of being overweight in the Arab region's population at different age groups, which leads directly to increase the opportunities of occurrence non-communicable diseases (NCD), especially half of the total deaths of this area is due annually to the spread of non-communicable diseases (Al-Momen & Nashter, 2022).

The obesity becomes have growing epidemic proportions progressively as a result there are with over 4 million people dying each year because of being obese in 2017 according to the global burden of disease (www.who.int/health-topics/obesity).The EDHS 2015 has disclosed that severity obesity constituted 9.8% among the children ranged from 5-14 which is considered an emerging concern by the officials (EDHS, 2015). Additionally, the Egyptian Medical Association in 2010 has estimated that 15% of the Egyptian children in education-age were obese, while this percentage was only estimated in 1990 by 6%. This indicates that the prevalence of obesity among children in school-age has doubled over the past 20 years, during the period 1990-2010 (Abd El-Fatah & Abu-Elenin, 2019). It has been revealed that the obesity becomes affecting steadily more the development of diabetes, hypertension, obstructive sleep apnea and fatty liver at long term, besides to having serious infections and several chronic diseases. As the estimated cases of deaths back annually to obesity's risk was about 115 thousand, amounted for 19.08% of the total deaths, and of which obesity cases amounted for 4 million in 2020. Furthermore, the cost of treating these chronic diseases associated with obesity was estimated about 62 billion Egyptian pounds annually, hence it constitutes a continuous economic burden and more psychological and social pressures on families on the Egyptian families as well (Aboulghate et al., 2021).

Consequently, there is a need for more comprehensive research that expands the evaluation of potential new factors that may have an impact on childhood obesity. Thus, by encouraging planners and officials to seek out quick, alternative solutions or effective controls that can significantly reduce the catastrophic health consequences of these chronic diseases caused by obesity, taking into account the progression of human age, up to the stage of adulthood, and ending with the stage of old age, this research's demographic direction could help Egyptian officials and organizations mitigate the risk of obesity by implementing proactive measures that have effective scenarios to limit this risk at minimum level. As consequence, this study sought to investigate the potential impact of several factors in the weight discrimination of Egyptian children <15, it was concentrated on the childhood years based on the derivation of a statistically significant function that could classify the child's weight into two categories: non-obesity or obesity case.

3. Justification

- Countries face a significant challenge in halting the growth in obesity and reducing obesity across all age groups in order to fulfill global commitments, so this is why immediate, comprehensive, and global action is essential (World Obesity Federation, 2022) in which obesity (BMI 30kg/m2) is predicted to affect 1 in 5 women and 1 in 7 men by 2030, equal to nearly 1 billion people globally, besides the majority of obese individuals today reside in LMICs, where the twin burden of malnutrition persists and systems are woefully underprepared and ill-equipped to manage obesity and its repercussions (World Obesity Federation, 2022).
- Lack of specialized statistical studies in the Arab countries focused on examining the problem of obesity in childhood from a purely statistical perspective, in which it could set-up a significant scenario of controlling the risk of obesity accepted statistically and be based on the derivation of a discrimination function could classify the state of the Egyptian child's weight whether obesity or non-obesity.
- A lack of scientific directions that can employ statistical techniques and in-depth analysis as approaches for problem-solving regarding examination of the factors affecting the prevalence of obesity, and it could be adopted by the officials and governments towards controlling the limitation of the obesity prevalence as potential risk facing the childhood at the long term.
- The obesity issue is considering one of the critical factors that could diminish the development progress and thus undermining the social and health policies of the developing countries and the subsequent reduced condition of countries' productivity for becoming Future-Proof due to the negative consequences of obesity facing the different ages of childhood.

- Focusing on using the statistical perspective to highlight the impact of addressing the obesity among children < 15 will support them for becoming more productive in society according to having a sound physical, health, psychological and social capabilities which help them to integrate and participate effectively in sustainable development of the state.

4. The Objectives Of Study

- To assess the potential factors or determinants that have a statistically significant impact in distinguishing between the BMI categories of the Egyptian child whether has obesity or non-obesity, according to the available data in the EDHS of 2015.

- To derive a discriminatory function that has the statistical ability to distinguish between two cases of child BMI in terms of obesity or non-obesity.

5. Literature Review

The current study explored a series of previous studies in chronological order, from the earliest to the most recent one. Plainly, it has been examined those stunted children could have a probability of obesity's risk based on the data collected form national survey in Egypt for studying the obesity of the population by assessment of the BMI, and it was concluded that short stature has significant impact on the obesity (Ibrahim et al., 2010). According to one study, the highest prevalence rates of childhood obesity have been reported in developed countries; nevertheless, its prevalence is increasing in developing countries as well (Badawi et al., 2013). It turned out that the likelihood of obesity was higher in children whose fathers worked in professional positions alongside children whose mothers worked (Salma & Ajeel, 2013). Childhood obesity is a big worry that puts children at risk of impaired cognitive abilities, physical health, and the development of many chronic diseases later in life and according to the findings of one study, obese children showed inadequate thinking skills than their normal-weight counterparts (Ameen & Abdelazeim, 2015).

One of the studies aimed to determine the prevalence of obesity among children of primary school in Mania Governorate in Egypt by examining a set of potential socio-demographic factors affecting the obesity and recommended to approach more anticipatory studies for keep monitoring the weights and heights of children in school-age regularly to limit the prevalence of obesity (Hossein & Almarhomy, 2017). It was concluded that there is a correlation between gender, residence, higher socioeconomic status standard, and fast-food intake and the development of obesity in primary school children, and this study advocated that there is an increased requirement to raise community awareness about obesity, its consequences, emphasizing obesity prevention measures, and promoting physical activities (Allam & Morad, 2018). Obesity is a major pediatric public health issue since it increases the risk of problems in childhood and leads to morbidity and mortality in adulthood. Another study aimed to assess the prevalence of obesity for primary school phase of the children in Behera Governorate by using a cross-sectional survey, and it revealed that the prevalence of stunting and obesity were correlated significantly with the rural area in Egypt (Abd El-Fatah & Abu-Elenin, 2019).

One of the most important public health issues is childhood obesity in which it will have a significant impact on children's health in the future. Overweight children are more likely to grow up to be obese adults (Al-Ani et al., 2020). Likewise, another study estimated the burden of obesity to society as critical point in determining the most priorities for increasing awareness among Egyptian families (Aboulghate et al., 2021). Childhood obesity has posed a severe public health concern in the 21st century, affecting both physical and emotional health in children (Hamza, 2022). As it has been concluded that there were significant associations between childhood obesity and education, physical activity, snacks, and TV watching (Al-Momen & Nashter, 2022). It has been concluded by another study that there is no significant correlation between childhood obesity and socio-economic factors like mother’s education, wealth index, place of residence and mother’s occupation based on the data derived from the EDHS in 2014 (Hamza, 2022). Another study sought to investigate the impact of wealth, mother education, and place of residence on childhood obesity in Egypt (Ahmed & Mostafa, 2023).

7. Methodology

To boot, the research was based on the examination of the proposed discrimination function in terms of its statistically significant impact in order to distinguish between the two categories of Egyptian child weight that either has obesity or non-obesity in light of the EDHS of 2015; and the current study relied on the data available of sample amounted to (N =10868) taking into account the consistency of the target variables or factors under the current study's interest. The inductive approach was used by this study to link the initial premises and the results. This approach based on the inference of particular instances from a general law, so it aims researching generalities and gradually obtaining substantial details.

In this case, the study relied on both descriptive and inferential statistical analysis for the sample's 2015 EDHS data to discover the obesity characteristics among the target children population <15 years old in Egypt, and to determine the most important factors that play a significant role in the discrimination of the Egyptian child's obesity state. The data used for the study came from the 2015 Egyptian Demographic and Health Survey (EDHS) for the country of Egypt. As a result, in order to meet the study's objectives, this study focused on data relating to children under the age of 15, including the EDHS 2015 database for Egypt. Based on the international KPI of the body mass index (BMI), the data of children's weight less than 15 years old were divided into two main groups (obesity or non-obesity). For the purpose of achieving the objectives of the current study, the first group of non-obesity case among children <15 years old was classified as a BMI less than 29.9 kg/m2, whereas the second group of pure-obesity case among children <15 years old was classified as a BMI greater than 29.9 kg/m2. The BMI-calculated of weight using WHO scales were classified into (6) main classifications, in particular for 4-6 rows.

The body mass index (BMI) was calculated from using the following two formulas:

Measurement Units	Formula and Calculation
Kilograms and meters (or centimeters)	Formula: weight (kg) / [height (m)]^2
	➢ The formula for BMI is weight in kilograms divided by height in meters squared. ➢ If height has been measured in centimeters, divide by 100 to convert this to meters.
Pounds and inches	Formula: 703 x weight (lbs) / [height (in)]^2
	➢ When using English measurements, pounds should be divided by inches squared. ➢ This should then be multiplied by 703 to convert from lbs/inches^2 to kg/m^2.

Furthermore, several statistical approaches were used to extract the results depending on the nature of the data measurement and the type of variables that would be suited for each procedure individually. The measures of descriptive statistics analysis (frequencies, percentages, means, and standard deviations) were extracted using IBM-SPSS Ver.26, including frequency distribution tables and cross-tabulation of the key variables, to describe the main characteristics of the current study sample, whose cases were drawn from the EDHS 2015 according to data cleanings and exact revision to assure consistency and quality of these data relevant to children aged 0-14 years, and the selection process was considered no-missing or incomplete data in any variable included in this study.

Additionally, it was limited to the variables available in the EDHS database for 2015. The Chi-square test was used to examine whether there was a potential association relationship between children's weight cases (obesity or non-obesity) and some qualitative characteristics that could have a statistically significant impact. as well as, Hypotheses test was used by using t-test of independent samples to examine the difference between the means of two groups of children weight (obesity or non-obesity) to determine the relative differences statistically that could be attributed to the impact of some quantitative variables.

The Discriminant analysis one of multivariate data analysis techniques that is focused on four aspects such as formulation, interpretations & uses of discrimination, estimation, and classification to examine the issues, problems, and recent development. Therefore, the discriminant analysis was applied by this study for the classification purposes about specific issue of the obesity among the children less than 15 years old, and for taking the interested researchers to pre-Fisher conceptualization of the two-group classification of the children weight, through K-group formulation as a significant statistically function of the classification (Huberty, 1975). the discriminant analysis was considered for supporting the achievement of the key direction of the current study, so, it was applied to derive a discriminatory function that could be classify the cases of Egyptian children into only two main cases whether obesity or non-obesity.

Mainly, this direction will propose a function resulting from the discrimination analysis that discriminates between two cases of children's weight (obesity or non-obesity) according to the impact of the variables included in this function based on its significant impact statistically in the classification process. This analysis applied based on using stepwise method that can reflect the ability of some variables which are acceptable statistically to distinguish between the two main cases of children’s weight in one function derived. This function has specific coefficients will be allocated to each variable included within proposed model in-separately. This analysis comes for the purpose of supporting expectations and efforts by specialists in the health, population, developmental and other fields as preventive and proactive measures about classifying the child’s weight status. Consequently, it may consider a one of new effective control that can be adopted to mitigate the severity of obesity risk among Egyptian children <15 years old. As a result, they could be qualified for future-ready and becoming future-proof oriented towards boosting sustainability by improving BMI, as aimed internationally, thus in-turn to ensure high levels of physical health quality among future generations. Derivation of linear discriminant analysis (LDA) decision boundary in which the question used for linear discriminant analysis for p=1 (1 answer) and the discriminant score of the diagonal-covariance LDA for class k is:

$$\delta_k(x) = -\sum_{j=1}^{p} \frac{(x_j - \bar{x}_{kj})^2}{s_j^2} + 2\log \pi_k, \quad (1)$$

Σk is the covariance matrix of each class k. And it can be able to transform into the next formula, as follows:

$$\delta_k(x) = -\frac{1}{2}\log|\mathrm{diag}(\sigma_j^2)| - \frac{1}{2}\sum_{j=1}^{p}\frac{(x_j-\mu_k)^2}{s_j^2} + \log \pi_k \quad (2)$$

Explanation of the variables:

- s_j is the Standard Deviation of the jth gene
- $\bar{x}_{kj} = \sum_{i \in C_k} \frac{x_{ij}}{N_k}$ mean of the N_k values for gene j in class k
- C_k Indexset for class k
- π_k Prior probability of class k, $\sum_{k=1}^{K} \pi_k = 1$
- $\mu_k = \bar{x}_{kj}$

8. Results & Discussion:

To achieve the current study's objectives, it has been relied on utilizing appropriate statistical methods for the sample of the DHS of 2015 in Egypt, as well as cleansing the available data for this purpose. The sample size used was (N = 10,868), representing Egyptian children <15. The following table shows the most essential key factors used to characterize the study's sample:

Table 1. The key variables for the 2015 DHS sample of children <15 in Egypt

Background Characteristics		N = 10868	Out of 100%
Government	Assuit	628	5.8
	Cairo	602	5.5
	Souhag	577	5.3
	Giza	569	5.2
	Qena	531	4.9
	Fayoum	521	4.8
	Menya	516	4.7
	Behera	509	4.7
	Beni Suef	509	4.7
	Sharkia	478	4.4
	Kalyubia	466	4.3
	Luxor	428	3.9
	Ismailia	423	3.9
	Aswan	413	3.8
	Menoufia	400	3.7
	Gharbia	389	3.6
	Damietta	385	3.5
	Suez	380	3.5
	Kafr El-Sheikh	377	3.5
	Dakahlia	367	3.4
	Matroh	353	3.2
	Alexandria	339	3.1
	Port Said	308	2.8
	Red Sea	202	1.9
	New Valley	198	1.8
Residence	Rural	6128	56.4
	Urban	4740	43.6
Gender	Male	5600	51.5
	Female	5268	48.5
Family Size	More than 2 Childrer	9644	88.7
	2 Children or less	1224	11.3
Hepatitis C	Negative	10848	99.8
	Positive	20	0.2

Hepatitis B	Negative	10857	99.9
	Positive	11	0.1
Education	No education	4985	45.9
	Primary	4337	39.9
	Secondary	1546	14.2
Hospitalizing	Yes	2457	22.6
	No	8411	77.4
Surgery	Yes	1482	13.6
	No	9386	86.4
Vaccination	Yes	10857	99.9
	No	11	0.1
Circumcising	Yes	866	8.0
	No	10002	92.0
Breastfeeding	Yes	477	4.4
	No	10391	95.6
Obesity	Non-Obesity	8587	79.0
	Obesity	2281	21.0

The results of table No. (1) revealed that the governorates of Assiut, Cairo, Sohag, Giza, and Qena had the highest percentage of concentration of children under the age of 15 years, respectively, compared to the rest of the governorates of the Republic, while the governorates of New Valley, Red Sea, and Port Said had the lowest percentage of concentration of this age group. The percentage of these children under the age of 15 in rural regions amounted to 56% of the overall sample data, compared to around 44% in urban areas. Male children of them constituted 52% of the total, while female children constituted 48%. Their percentage within households with more than two children was 89%, while their percentage in households with two or less children was 11%.

Table No. (1) has also shown that the percentage of children < 15 years old was higher among children outside the basic grades of school, reaching 46%, compared to 40% and 14% in primary and secondary education, respectively. While the percentage of these children < 15 who were not breastfed was greater, reaching 96%, compared to 4% who were breastfed. In addition to the percentage of children <15 who were obese was 21% lower than that of those who were not obese, reaching 79%. The following table also depicts the most important quantitative characteristics of the survey sample of children under the age of 15 in terms of average years of education, the child's rank within the family, the child's age, weight, height, and body mass, in order to shed more light on the extent to which the study sample's data is centered around the average value in a way that contributes to drawing the general features of the sample. Children under the age of 15 are counted as follows:

Table 2. The means and standard deviations of some quantitative variables summarizing the characteristics of children<15 of the 2015 EDHS

Variables	Mean	Std. D
Education in years	1.94	2.54
Child line number	2.15	1.27
Age in years	6.97	4.03
Weight in kilograms	14.186	3.36
Body Mass Index (BMI)	32.40	6.29
Height in Centimeters	92.01	10.41

years of age is clearly concentrated in younger ages in terms of age and stages of education compared to older ages within the same age group (0-15). It also shows that the average body mass index (BMI) for children under the age of 15 years is 32.40, which is higher than the threshold value for the risk of obesity, which indicates obesity if the BMI exceeds the value of 29.9, according to the international classification of body mass index (BMI) scale. Furthermore, figure No. 1 indicates the prevalence of obesity rates among children under the age of 15 in Egypt at the governorate level. The obesity prevalence rates of these children (0-15) range from 27% as a maximum to 15% as a minimum, as illustrated in the map of figure No.1 by the shaded areas looking darker, which reflect the area of obesity prevalence among this age group. The governorates with the highest incidence of children obesity have the darkest color, whereas the governorates with the lowest prevalence of childhood obesity have a light hue rather than a dark color. Depending on the severity of the prevalence of obesity risk among children and its variation from governorate to governorate, the darkest hue gradually goes to the lightest.

The current study used a representative survey sample of children under the age of fifteen from the EDHS of the 2015 to examine and monitor cases of child weight into two main classifications (obesity or non-obesity), based on an evaluation of the values of body mass index measurements. The body mass index (BMI) for the child's weight was classified into two cases (obese or non-obese) for the sample of children <15 years who were targeted for analysis based on the current study's considerations and limitations, so that if its value was greater than 29.9, it was considered a case of obesity for the child's weight, while if its value was less than 29.9, it was considered non-obesity for the child's weight based on global standards of the body mass index (https://www.cdc.gov). As a result, the survey sample of 10,868 children <15 was separated into two groups: children without obesity (2,281, 21%), and children with obesity (8,587, 79%). It represents the total number of sample items for which all possible values for the target variables should be selected with no defects or missing values until they are included in statistical analyses aimed at achieving the study's objectives. Afterwards that, descriptive analysis methods were used to examine the various levels and trends in classifying the BMI status of Egyptian children <15, with the goal of studying the statistically most significant relative differences in the level of two children's BMI categories (obesity or non-obesity), based on variables that reflect the basic characteristics of the survey study sample.

The Chi-square test was used to reveal the relationship between the child's BMI measure as a dependent variable and the independent variables of a descriptive nature using cross-tables (based on frequency and relative distribution %), and the results of this analysis was disclosed in the next table No. (3). In general, using Chi-Square test analysis to examine the statistical correlation between the child's weight status (obese/non-obese) and a number of selected descriptive variables resulted in; As shown in the previous table No. (3), there is a significant correlation between the child's weight status and all variables of interest to the study, with statistical significance at a level less than 0.05, meaning (p-value < 0.05). This indicates the impact of these variables on the child's weight status, whether obese or not, while four descriptive variables were excluded from the analysis outputs, represented by (the governorate/ vaccination status/ the child's infection with hepatitis B/ the child's infection with hepatitis C), where each correlation relationship of these variables with BMI of the Egyptian child using the chi-square test was not significant at a level less than 0.05, meaning (p-value > 0.05), as a consequence of this, there was no statistically significant relationship between any of those variables and BMI on individually.

Furthermore, the findings revealed a substantial relationship between the child's weight status and the residence. It was discovered that the percentage of childhood obesity increases in rural areas, where it represents approximately 22%, while it is lower in urban areas, where it represents 19%, indicating a rise in childhood obesity in the rural community, which may suffer from following unhealthy or improper nutritional methods, which may cause a rise in excessive obesity. The findings also revealed a significant correlation between the child's weight and gender at a level less than 0.05, as the percentage of obesity among male children climbs by nearly 23%, while it reaches 18.8% among female children. Based on the indication of a significant correlation between the child's weight and household size at a level less than 0.05, the results also show an increase in the rates of obesity cases among children in households with more than two children, as reached 28.8%, compared to their percentage in households with two children or less, as reached 20%.

Table 3. the percentage of children ≤ 15 according to the obesity classification and examining its relationship to the basic characteristics selected from the EDHS of 2015

Background Characteristics		Obesity Classification		No. of Cases	Chi-Square Sig.
		Non-Obesity	Obesity	Child ≥ 14	
Government	Cairo	83%	17%	602	0.231
	Alexandria	82%	18%	339	
	Port Said	78%	22%	308	
	Suez	85%	15%	380	
	Damietta	75%	25%	385	
	Dakahlia	76%	24%	367	
	Sharkia	77%	23%	478	
	Kalyubia	82%	18%	466	
	Kafr El-Sheikh	76%	24%	377	
	Gharbia	80%	20%	389	
	Menoufia	82%	19%	400	

	Behera	76%	24%	509	
	Ismailia	73%	27%	423	
	Giza	78%	22%	569	
	Beni Suef	77%	23%	509	
	Fayoum	77%	23%	521	
	Menya	78%	22%	516	
	Assuit	78%	22%	628	
	Souhag	78%	22%	577	
	Qena	81%	19%	531	
	Aswan	81%	19%	413	
	Luxor	80%	20%	428	
	Red Sea	80%	20%	202	
	New Valley	81%	19%	198	
	Matroh	84%	16%	353	
Residence	Urban	80.3%	19.7%	4740	0.003**
	Rural	78.0%	22.0%	6128	
Gender	Male	76.9%	23.1%	5600	0.000**
	Female	81.2%	18.8%	5268	
Family Size	2 Children or less	80.0%	20.0%	9644	0.000**
	More than 2 Childre	71.2%	28.8%	1224	
Hepatitis C	Negative	79.0%	21.0%	10848	0.227
	Positive	70.8%	28.2%	20	
Hepatitis B	Negative	79.0%	21.0%	10857	0.210
	Positive	63.6%	36.4%	11	
Education	No education	54.2%	45.8%	4985	0.000**
	Primary	90.6%	9.4%	4337	
	Secondary	94.7%	5.3%	1546	
Hospitalizing	Yes	82.5%	17.5%	2457	0.000**
	No	78.0%	22.0%	8411	
Surgery	Yes	89.7%	10.3%	1482	0.000**
	No	77.3%	22.7%	9386	
Vaccination	Yes	79.0%	21.0%	10857	0.332
	No	90.9%	9.1%	11	
Circumcising	Yes	97.5%	2.5%	866	0.000**
	No	77.4%	22.6%	10002	
Breastfeeding	Yes	88.7%	11.3%	477	0.000**
	No	78.6%	21.4%	10391	

* Statistically significant at a level less than 0.05. ** Statistically significant at a level less than 0.01.

The results of table No. (3) above clearly showed that there is a significant correlation between the child's weight and the progress of the Egyptian child's educational stage, as it indicated a concentration of obesity cases among children in the stage before enrolling in basic education, where it reached 45%, while the rates of obesity cases gradually decreased as the child's educational stage progressed. The level of education has grown, as the percentage of children in the primary school stage has reached 9%, while it has reached 5% in the secondary education stage. However, its impact is still increased in general for fat individuals because childhood is the peak of severity of obesity risk, prior to passing through the educational phases step by step, in which its negative impact could begin to diminish based on adopting effective controls that are limiting the impact of this risk in-advance in favor to grow the ages of children at later phases of education. This result indicates the importance of education in reducing the factors of obesity and for the child to acquire the necessary awareness components in order to maintain a healthy and fit body, which reflects the existence of a direct relationship between child obesity and the child’s progress in the educational stages from one stage to another. As it turns out, detecting cases of obesity necessitates paying attention to the child's primary health care needs during the pre-basic education stages, while being guided by how to follow the best policies and sound nutritional behaviors that give the child a better ideal weight in a way that limits the exacerbation of the phenomenon of obesity risk.

Similarly, there is a statistically significant relationship between the child's weight status and each of the descriptive variables reflected in both of the vaccination status, hepatitis C status, hepatitis B status, circumcision status, and breastfeeding status at a level less than 0.05. As consequently, it has been discovered that children with positive cases of hepatitis B or C, children who have not been exposed to medical or surgical conditions, children who have not received vaccination, children who have not been circumcised, and finally children who have not been breastfed have higher rates of obesity. As a result, many health, social, and demographic organizations consider these areas to be interesting for further investigation and in-depth analysis in order to identify the driving forces for this, which may be due to other causes, some of which are resulting from following unhealthy aspects and improper habits to which children under the age of 15 have been exposed, which could have adversely affected the high rates of obesity.

A t-test for independent samples was used to study the impact of differences that are subjected to some factors in order to achieve another goal of the current study related to evaluating the most important factors or potential determinants that have a statistically significant impact in distinguishing between the body mass index classification of the Egyptian child, whether he is obese or not obese. Significant differences in body mass index averages between two groups of children under the age of fifteen (obese/non-obese), which may be attributed to the impact of some of these factors in light of what is available in the 2015 survey sample. The independent samples t-test findings revealed statistically significant relative differences that were caused by the impact of some factors on the difference and categorization of an Egyptian child's BMI, whether obesity or not, as follows:

Table 4. The results of an independent samples t-test used to examine the relative differences in BMI of Egyptian children <15 based on the impact of some variables

Quantitative Variables	Child Obesity	N	Mean	STD.	T-test
Child line number	Non-Obesity	8587	2.10	1.20	-7.589**
	Obesity	2281	2.33	1.40	
Age in years	Non-Obesity	8587	8.02	3.89	60.795**
	Obesity	2281	3.03	.90	
Education in years	Non-Obesity	8587	2.45	2.63	44.546**
	Obesity	2281	1.03	0.00	
Weight in kilograms	Non-Obesity	1296	11.07	1.36	-58.355**
	Obesity	2281	15.96	2.83	
Height in Centimeters	Non-Obesity	1294	82.75	7.32	-53.875**
	Obesity	2281	97.26	7.96	
Body Mass Index (BMI	Non-Obesity	1293	26.77	2.35	-54.443**
	y	2281	35.59	5.54	

* Statistically significant at a level less than 0.05. ** Statistically significant at a level less than 0.01.

The results of the t-test for independent samples revealed that there were significant differences in the means of the children's body mass index for the two groups of children with obesity or children without obesity, which could be attributed to the impact of some variables, as the t-test values for each comparison separately were statistically significant at a level less than 0.05, such as the child's rank within the family, weight, height, and body mass index averages. For each comparison result related to analyzing each variable independently, these differences were significant in favor of the value of the averages of the group of children with obesity, as they were greater than the value of the averages of the groups of children without obesity.

In contrast, there were statistically significant differences at a level of less than 0.05 between the two groups' averages due to the impact of both the variables of the child's age and the number of years of education separately, where the significant differences are due to the value of the averages of these two variables for the group of children without obesity being higher than the value of the averages of the other group of children with obesity. This could be due to the presence of significant impacts of the child's rank, weight, and height in increasing the risk probability of obesity among children <15, thus this will be led to more research efforts to focus predominantly on these variables in reducing the phenomenon of obesity risk or placing them as triggers of the risk of obesity among children in the early ages of this age group (0-15), as the current study is targeting.

This section of the study will now examine the most significant factors or variables that contribute to the distinction in identifying the weight status of children under the age of fifteen (obese or non-obese). As a result, statistical discriminant analysis was used primarily to derive a discriminant function that can distinguish between the weight classification of children <15 as a dependent variable into two main groups based on the assessment of the body mass index value, whether it represents a case of obesity or a case without obesity. This is based on tracking the values of some variables whose data is available through the EDHS in 2015, which reflect the basic features and characteristics of children <15 in a consistent and accurate manner with high quality and no data missing in tracking its values included in this survey in order to study and analyze the impact of those targeted variables. The variables were selected based on the findings of previous research and studies focusing on this study on the problem of children obesity in general, as well as what it specifically stated in its future recommendations. The current study also considered the need to concentrate on monitoring the most important available characteristics or variables that have a statistically significant impact on creating classification and distinction between two groups of the dependent variable (the weight status of a child <15). To attain this purpose, the discriminant analysis approach was applied in two stages, as follows:

-**<u>The first stage</u> (**developing a model of discriminant function that contains all variables determined using the "**<u>Enter"</u>** method): At this stage of data analysis, discriminate analysis was used to achieve the study's objectives after classifying the dependent variable in the proposed model, children's growth status, into two main groups, so that the first group of the classification represents children <15 years of age who have obesity, and the second group of the classification represents children <15 years of age who have normal growth without obesity. In this stage, the discriminant analysis was used to discover which variables included in the function derived from discriminant analysis were more predictive for distinguishing between two main groups of the dependent variable. The Wilk's Lambda test was used to determine if the contribution of each of the variables of interest in the current study, which were entered into the Discriminant Analysis Function, is statistically significant in distinguishing between the two groups of children, obesity and non-obesity. Examining the values of this test (λ) revealed that there is a contribution of some variables that are statistically significant at a level of less than 0.05 in distinguishing between two main groups of the dependent variable (the BMI scale of the children <15), implying that there is a difference between two groups, children with obesity and children with normal growth non-obesity. The Wilks-Lambda coefficients test results for the research variables of interest are shown in the table below:

Table 5. Wilk's Lambda coefficients that determine the significance of the variables selected contribution in distinguishing between two groups of children <15 in Egypt (obesity/non-obesity)

Key Variables	Wilks' Lambda	F	Sig.
Governorate	1.000	0.931	.335
Vaccinations	1.000	0.940	.332
Hepatitis C	1.000	1.459	.227
Hepatitis B	1.000	1.570	.210
Residence	0.999	8.634	.003**
Hospitalizing	0.998	23.875	.000**
Breastfeeding	0.997	28.185	.000**
Gender	0.997	30.312	.000**
Family Size	0.995	50.440	.000**
Child line number	0.995	57.599	.000**
Surgery	0.989	120.477	.000**
Circumcising	0.982	196.566	.000**
No. of Education years	0.846	1984.347	.000**
Educational level	0.752	3580.420	.000**
Age	0.746	3696.005	.000**

* Statistically significant at a level less than 0.01.** The lower the value of the Wilk's Lambda test for every variable in the proposed model, the more likely it implies that its contribution to the discriminant analysis is statistically significant using F-test.

According to the previous table, some of the variables of interest were statistically significant at a level less than 0.05 in classifying or distinguishing between the two main groups of the dependent variable, whether obesity or non-obesity, whereas the rest of these variables were not statistically significant in distinguishing. As a result, the non-significant variables were removed from the derived discriminant function, and the discrimination analysis method can be repeated with the objective of achieving statistically significant differences between the means of the two main groups of the dependent variable (Egyptian Children' Weight), whether obesity or non-obesity. It is also clear that the child's age variable, with the lowest Wilks-Lambda coefficient value of 0.746, aids the most in distinguishing the dependent variable groups. This is consistent with research demonstrating that the BMI factor for child obesity may evolve as the children's age proceeds through the stages of growth (Khatab, 2010).

As the variable of the child's educational level therefore plays a role in distinguishing between two groups of the child's weight, whether obese or not, as the Wilks-Lambda coefficient reached 0.752, as predicted by some of the past study presented about this issue. It also indicated the significance of the variable number of years of education, as it had a statistically significant significance in discrimination, and there was also a statistically significant significance for the variables represented in each of (circumcision status, family size, breastfeeding, place of residence, the child's exposure to medical or surgical conditions, gender, child's rank), as demonstrated by assessing the significance levels and Wilks-Lambda test coefficients in the preceding table 5 findings.

The Box's M-test was used in the Discriminate Analysis Technique to test the extent to which the covariance matrix of the independent variables in the derived Discriminate Analysis function differed and to determine the extent of its variation within each group comprised of the dependent variable (child growth measurement status), and it was discovered that they were not different. Because the Box's M test value was not statistically significant, it is one of the fundamental conditions that needed to be investigated prior to applying the discriminant analysis method. The use of the discriminant analysis method also resulted in the derivation of a single function, as the number of functions derived from the discriminant analysis must be equal to (the number of groups of the dependent variable - 1).The table below shows the function extracted from the discriminant analysis, its eigenvalue and the percentage of its contribution to explaining The total variance of the two groups of the dependent variable in terms of distinguishing obese children from non-obese children. As therefore, this percentage will indicate the extent to which it is possible to identify and categorize a child's weight status, whether the child is obese or not, such that there is no conflict or overlap in discriminating between these two categories.

Table 6. The derived function extracted in the first stage of discriminant analysis and its eigenvalue

Function	Eigenvalue	% Of Variance	Cumulative %	Canonical Correlatio
1*	0.586	100.0	100.0	0.608

* Statistically significant at a level less than 0.05.

The discriminant analysis approach also shown that the derived function could explain the variations occurred in the dependent variable strongly satisfactorily by 100%. The Wilks Lambda test results confirmed that the estimated function is statistically significant at less than 0.05, as the chi-square value reached 5011.676. This result supports its capacity to distinguish between the dependent variable's two categories, obese and non-obesity among the Egyptian children. In addition to the percentage or classification power of this proposed model in discriminating cases of obesity or no-obesity for children <15 in Egypt was 83.3%. The table below demonstrates the degree of correlation between each of the variables in the study, which were entered into the discriminant function generated using the discriminant analysis method, and by examining the correlation matrix between each of the variables in the study and the derived discriminant analysis function separately, as follows:

Table (7): Correlation coefficients of the proposed variables and the discriminant analysis function derived in the first stage

Variables Proposed	Derived Function (1)
Age	0.762
Educational level	0.750
No. of Education years	0.558
Circumcising	-0.176
Surgery	-0.122
Child line number	-.091
Family Size	-.087
Gender	.069
Breastfeeding	-.067
Residence	-.037
Hospitalizing	-.035
Governorate	-.012
Hepatitis B	-.010

Vaccination	.005
Hepatitis C	-.003

* It denotes to the highest correlation coefficient between the variable and the derived DAF.

The previous table clearly reveals that the child's age variable (i.e., the older the child becomes during the early stages of his life cycle) has a higher correlation with the discriminant function derived from discriminant analysis than the other variables, allowing it to be classified with this function in the first place, and thus the change in the child's age during the stages of his growth ages. Thus, this variable contributes in distinguishing between groups of the dependent variable (the children's weight status), implying that it has the biggest influence in predicting whether the child is obese or not according to international standards. The table data also revealed that each of the following variables (educational level, No. of education years, circumcision status, exposure to surgical operations) respectively follows the child's age variable in the strength of the correlation relationship with the derived function, thus those variables could be classified with this function derived.

As a result of that, these variables provide a significant contribution to categorizing or distinguishing the obesity status of Egyptian children <15. However, the remaining variables involved in this function have a weak connection with the derived function. Therefore, using this derived function to distinguish between the two cases of the dependent variable, these variables with a very weak correlation relationship could not be classified to a significant degree, particularly the variables represented by (governorate, vaccination, hepatitis C, and hepatitis B). Accordingly, the current study preferred to exclude those variables based on Wilk's Lambda-test results when re-applying the second stage by using discriminant analysis method with the objective of accessing a discriminatory function based directly on the variables that have the highest significant impact or highest correlation relationship in classifying the child's weight and obesity status in terms of the presence or absence of obesity.

-**The second stage** **(**rebuilding the suggested model after eliminating variables that, as a result of the first stage analysis outputs, have no significant impact on the correlation with the derived function using the "**Stepwise"** method): Using the discriminant analysis method once more after being satisfied with the variables from the first stage analysis that have the highest correlation in measuring change or classifying two groups, the child's weight status, and dropping the non-significant variables from the previous model to ensure accessing for the best efficient model which will be capable of classifying and distinguishing between two measurement cases of the child's weight, whether there is obesity or not, especially since retaining non-significant or non-correlated significantly variables would not greatly increase the proposed model's efficiency or capacity to distinguish between what should be targeted. The Stepwise method was used to identify variables in the new derived function that have a higher significant correlation with the dependent variable, while deleting variables that have a lower correlation with the dependent variable, and to avoid excluding potentially strong relationships among the set of independent variables included in the derived function itself.

The following table shows the new derived function's ability to explain the variance between two groups in the case of the dependent variable BMI status (or child's weight) in terms of there is obesity or non-obesity, and based on the presence of only 7 independent variables in the new function, with the exclusion of some variables using the Stepwise method, which has a non-significant effect and a lower correlation. The dependent variable, and thus the new derived function, reflects its ability to contribute to distinguishing between the two groups of the dependent variable, provided it does not conflict or interfere with them, and the % of variance explained by that function is shown in the table below:

Table 8. The derived function extracted in the second stage of discriminant analysis and its eigenvalue

Functior	Eigenvalu	% Of Varian	Cumulative	onical Corre	Vilks' Lam	Chi-squa	df	Sig.
1*	0.685	100.0	100.0	0.806	0.631	5007.48	7	.000

* Statistically significant at a level less than 0.05.

The discriminant analysis results showed that the new derived function could contribute to distinguishing the changes occurring in the dependent variable by 100%, as the Wilks-Lambda test showed the significance of the derived function at a level less than 0.05, as the chi-square value reached 101.140, and this also confirms its ability to distinguish between two groups of the dependent variable (the child's weight status), that is, between the two statuses (obesity/non-obesity). The canonical correlation coefficient for this function was 0.806, and consequently the coefficient of determination (r^2) was 64.9%. In turn, this represents the percentage of the total variance in child weight measurements that can be explained by this new model, which includes the new variables proposed within it, as the Wicks Lambda-test value also demonstrated the significance of this new model and its validity for predicting the values of the dependent variable. As a result, it can be relied on to distinguish and classify the two cases of Egyptian child weight targeted by the current study, so the following table will show the coefficients of the derived discriminant analysis function, which contribute to distinguishing between two groups of the dependent variable of child weight (obesity/non-obesity) as follows:

Table (9): Discrimination loadings and results of standardized and non-standardized coefficients for the analysis of differentiation for the variables used in classification of child growth (obesity or non-obesity)

Variables	iscriminant Loadings	Discriminant Function (1)	
		Standardized Coeff.	on-Standardized Coeff
Age	.762	1.448	.416
Educational level	.750	.663	1.080
o. of Education years	.558	-1.148	-.491
Gender	.069	.119	.238
Circumcising	-.176	.050	.187
Residence	-.037	-.058	-.117
Breastfeeding	-.067	-.587	-2.870
(Constant)		–	2.400

According to the results of the previous table (9), the discrimination loads for the current child's age contribute the most compared to the other variables, with a classification of 76% in the segmentation between the two growth cases of the Egyptian child, whether obesity or non-obesity. Then followed by the discrimination loads for the educational level variable and the number of years of education variable, respectively, were considered in terms of the classification or division ratio between the two growth cases of the Egyptian children under 15 years old. Based on the current study's data, we can distinguish between two cases of child development, whether obesity (2) or non-obesity (1), by predicting the number of the group to which it belongs by formulating the discriminant function equation using the standard coefficients as follows:

$$\text{BMI-Child} \geq 14_{\,(\text{Obesity}=2\ /\ \text{non-Obesity}=1)} = [(\text{Age} * 1.448) + (\text{Educational level} * 0.633) + (\text{Education years} * -1.148) + (\text{Gender} * 0.119) + (\text{Circumcising} * 0.050) + (\text{Residence} * -0.058) + (\text{Breastfeeding} * -0.587)] \quad (3)$$

The standard values for each of the variables (of interest in the current study) could be inserted into the equation described above in the same way to establish which discriminating group the child's weight status is following in terms of obesity or non-obesity. Therefore, this derived discriminant function could be utilized in predicting the population to which each new BMI scale for an Egyptian child <15 belongs in the future. The discriminant analysis findings also revealed that this new proposed model's capacity to classify two cases of child weight <15 in Egypt, whether obese or not, achieved roughly 83.9%, which is regarded a very outstanding classification performance, especially since it is preferred that the ideal division percentage for models generated from the discriminant analysis approach be 74% or higher as a standard percentage for determining the classification model's validity (Al-Abbasi, 2011). This opens the way for future research to test other critical dimensions and variables in this proposed model, yielding a higher ideal percentage that may assist in improving the model's capacity to categorize the weight status of Egyptian children <15. As, the table below shows the accuracy classification efficiency of the resultant model, and the second stage's discriminant analysis shows how much it varies from the chance component, as follows:

Table (10): The proposed model's division efficiency and the level of difference from chance in categorization or division of child growth measures (obesity or non-obesity).

Obesity Categories	Predicted Group Membership		Total
	Non-Obesity	Obesity	
Non-Obesity	6889	1698	1635
	%80.2	%19.8	%100
Obesity	54	2227	8587
	%2.4	%97.6	%100

Moreover, this proposed model requires more additions by allowing researchers to examine the impact of many variables and other characteristics surrounding each mother or child, whether demographic, social, economic, environmental, genetic, or otherwise, through additional studies and research. This study focuses on the issue at hand of childhood obesity in general. It also intends to investigate the significance of reaching at precise estimations in order to raise the level of differentiation or categorization necessary for the condition of child obesity. Further, this study can be regarded as one of the serious scientific endeavors that may significantly contribute to highlighting the importance of monitoring the issue of childhood obesity <15 and classifying it in light of monitoring the child Body Mass Index (BMI) scales recognized by international bodies such as the World Health Organization (WHO) in order to develop any plans to develop and improve the child health in Egypt. Besides, this study may additionally serve as a starting point for future studies in the field of medical and demographic statistics to increase interest in the ideal weight of the child and the most important factors and determinants affecting child obesity, which can sometimes lead to extreme obesity. Consequently, this necessitates more costly surgical and therapeutic interventions at all stages of life, which may pose more health, living obligations, and economic burdens and on Egyptian families. As a result, taking preventive measures by specialists and society itself is preferable to corrective measures later on, by identifying the most important factors and determinants influencing the occurrence of childhood obesity in order to easily deal with and direct it at an early stage in order to save effort and cost, support the child's health, and maintain an ideal weight later on.

9. Recommendations

In recap, the current study has submitted in this section a set of general recommendations based on an examination, revision, and in-depth analysis of the available data for a sample of 15 Egyptian children from the EDHS in 2015 in order to conclude the most important results about evaluating the highest variables and factors influencing that could be contributed to the classification of Egyptian children's body mass conditions into two basic groups whether (obesity or non-obesity) and to pave the path for future research and studies on this topic and its hazards to children's health as well. A set of recommendations and solutions derived from the study's findings are presented as indicative action directions in this section to assist decision-makers, local and regional policies, officials, and planners of development and health programs in the Arab Republic of Egypt, and this endeavor aims to incentivize more efforts by Egyptian social or educational institutions and families to increase attention to the Egyptian child's health in the coming periods, those potential directions are coinciding with global interest in measuring governments' progress toward achieving the SDGs by 2030.

All of this would serve to improve sustainability opportunities and the long-term possibilities for qualifying a rising generation of Egyptians who possess the psychological, social, environmental, health, and nutrition components that keep them free of chronic diseases and the risks associated with obesity. As a result, today's children will be the workforce of the future, capable of effectively and efficiently participating in the wheel of comprehensive development in all fields and sectors, prompting the current study to provide solutions and recommendations as a classification of long-term strategic directions to create a better tomorrow for the Egyptian child, so that they are targeted by flexible and agile competent authorities of Egypt in becoming future proof in the next series of generations. Following on from the preceding, the recommendations have been divided into work groups that may assist to improving sustainable development opportunities in the health & environmental, social, and economic directions, as follows:

Working Group on Health and Environmental Dimension:

- Focusing on continuing to raise awareness of healthy and proper nutrition methods in schools and among all categories of Egyptian families, while monitoring progress by measuring the Egyptian child's body mass index on a regular basis at all levels of education, as a standard ratio compared to the child's weight and height at each stage, and thus it supports monitoring the risks of obesity in children within families to ensure weight reduction to an acceptable level of obesity risk threshold.

- Highly mature planning to manage the health and environmental risk of childhood obesity by raising triggers as warning alarms of this risk in front of all parties involved, whether at the family or school level, and to be guided by it in the event of its occurrence to implement effective scenarios and preventive measures in a timely manner, and to reduce the prevalence of obesity at the governorate levels, not exceeding the permissible risk appetite in accordance with the aspects of long-term health and environmental planning.

- Promoting the implementation of health programs and initiatives aimed at changing the child's nutritional behavior using various social networking tools and the opening of advanced smart platforms in all public places and gatherings, as well as the use of websites and expanded media outlets to familiarize the child with healthy eating habits based on the dissemination of actual practices used with specific children or families.

- Participation of medical and nutrition institutions and organizations in emphasizing the importance of reducing the number of fast foods high in fat and calories while following a healthy diet for all Egyptian families through periodic assessments to monitor the high severity of the risk of obesity based on positive plans and proactive and preventive measures as well. This tendency is a crucial technique for measuring the state's progress in BMI scales toward children's wellbeing <15, as part of the rivalry in the environmental and health domains between regions and governorates, particularly in remote places. As a result, this demonstrates the long-term durability of children's health while providing good incentives to concerned authorities and families living in such advanced regions or governorates to encourage the remaining places to follow suit in favor of children.

Focusing on specialized environmental and medical campaigns to combat the risk of obesity, targeting primarily children with positive cases of hepatitis B or C, children who have been exposed to medical or surgical conditions, children who have not received vaccination, children who have been circumcised, and finally children who have not been breastfed. According to the current study's findings, these factors are recognized that have significant impacts on increasing the obesity risk aggravation. Thence, more research and studies on this topic are required to properly comprehend its medical origins.

- Developing a national plan at the Egyptian state level to adopt clear environmental and public health guidelines regarding effective measures to reduce childhood and adolescent obesity, and by adopting an approach that focuses on lowering the health risks of the most severe actual impacts on the body mass conditions of overweight or obese children, while developing quantifiable targets and indicators to monitor progress in health and the environment levels over the children less than fifteen years old in Egypt.
- Adopting strategic health and environmental initiatives and programs to accelerate the national plan objectives aimed to combat the risk of obesity, including, but not limited to, reducing consumption of exaggerated foods high in calories and low in nutrients and increasing opportunities for children to participate in physical activity through expanded government promotion of recreational activities and sports at the level of governorates and regions suffering from a widespread risk of obesity.

Working Group on Social Dimension:

- Increasing prospects for obesity awareness programs in rural regions, given Egypt's countryside's greater obesity incidence among children <15 compared to urban areas. Rather of focusing just on big cities, stimulate physical activities, games, festivals, and sports races with the involvement of sports and artistic stars, particularly among male children in remote areas at the regional and governorates levels.
- Need to prevent obesity-related bullying and to accelerate the search for quick alternative weight-loss solutions with the participation of family heads, it is necessary to have mandatory or optional incentives to encourage children <15 to participate in all sports activities and exercise on a weekly basis, while also providing moral and psychological support to children.
- Intensifying awareness program opportunities among households with more than two children compared to the size of households with two or fewer children, particularly this trend contributes to reducing Egypt's population growth, which is devouring the elements of sustainable development in the absence of manpower planning by focusing on the future in order to ensure the optimal use of labor force and control of the minimum dependency ratio of children under 15 years old.
- Setting-up controls and measures that contribute to controlling the social conditions affecting the spread of obesity risks, such as parental separation, an increase in births within the family, high living costs, and so on, must be established to ensure the Egyptian family's psychological and social stability, as well as to demonstrate the desired interest in the health of the Egyptian child.

Working Group on Economy Dimension:

- Developing an economic scale index to assess the progress of the Republic's governorates in decreasing the risk of obesity via the use of electronic or smart solutions based on artificial intelligence and digital transformation methodologies, and if possible, this would increase economic competitiveness in sharing information supporting global obesity reduction, and it would be applied smoothly and automatically by all users through the use of technological platforms for open data that are easily accessible by end users to monitor the rates of high or low risk of obesity among early age groups of Egyptian children in different phases, with the option of ranking the governorates of the Republic in accordance with which one is the highest severity of the risk of obesity and so on. This scale will also help distinguishing between the two main cases of BMI (child weight) by directing the inputs of the discriminant function derived from the current study's outputs to determine the level of classification in terms of obesity or non-obesity, and thus this scale will depend on the seven independent variables like (child' rank, age, educational level, No. of education years , gender, circumcision, residence, and breastfeeding) to determine which category classified the child's weight status in terms of obesity or non-obesity.

- Imposing significantly higher tax rates on products, foods, goods, and beverages with high calorie content in order to achieve a balanced diet, regardless of whether imposed on manufacturers or final consumers, because they are not considered basic needs in line with components of the quality of life that must be provided to ensure the children's well-being. On the other hand, they are viewed as unnecessary and recreational components that should be avoided, especially because they may cause long-term harm to the child's health and capacity to engage in production and promote economic growth elements.

- Disseminating comprehensive and early screening programs to measure body mass index in all commercial areas, markets, and large malls in exchange for financial fees collected personally or electronically to support state-level anti-obesity campaigns in governorates with a high prevalence of obesity risks for children under the age of 15.

- Many future studies will be required to incorporate new variables and other factors as inputs into the proposed model in order to track the opportunities and risks affecting the body mass of Arab children, not just Egyptian children, and this relates back to the MENA region's great similarity in social and economic components and environmental protection, the Arab child's health and development.

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آثار دالة تحليل التمايز في تصنيف السمنة لدى الأطفال أقل من 15 سنة في مصر

دراسة تطبيقية على بيانات المسح الديمغرافي والصحي 2015

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الخلاصة: بشكل عام، تم نشر عدد قليل نسبيًا من الدراسات الإحصائية حول تصنيف السمنة كتفكير قائم على المخاطر في مرحلة الطفولة بين الأطفال أقل من 15 عامًا في مصر. علاوة على ذلك، تعتبر السمنة من المخاطر الحاسمة التي قد تعيق التقدم نحو المستوى المنشود من التنمية البشرية بسبب أمراضها المصاحبة والأمراض المزمنة، خاصة بين الأطفال، والتي قد تستمر معهم من مرحلة الطفولة إلى مرحلة البلوغ والشيخوخة دون اتخاذ أي تدابير ملموسة. من قبل مسؤولي الدولة للسيطرة بشكل فعال على مدى خطورة هذا الخطر. ولهذا السبب، فإن اتجاه البحث في هذه الدراسة يدرس تأثير بعض المحددات الرئيسية المتوفرة في بيانات المسح الديموغرافي الصحي المصري 2015 (EDHS) لإثبات تأثيرها ذو دلالة إحصائية على تصنيف وزن الطفل المصري (السمنة أو عدم السمنة) بناءً على تجاوز عتبة الخطر 29.9 من مؤشر كتلة الجسم (BMI) لتصنيفها على أنها حالة سمنة مؤكدة. ولذلك ينبغي التركيز عليها من قبل المخططين لدعم أطفال هذه الفئة العمرية المختارة (0–14) حتى يصبحوا بالغين في مرحلة البلوغ.طبقت هذه الدراسة التحليل التمييزي لاستخراج تقنية إحصائية لتصنيف حالة وزن الأطفال، ومن ثم تم اشتقاق دالة تمييزية جديدة قادرة على تصنيف مؤشر كتلة الجسم للأطفال المصريين أقل من 15 بنسبة 65% إلى مجموعتين رئيسيتين: السمنة أو غير السمنة على سبعة متغيرات تتمثل في العمر، المستوى التعليمي، سنوات الدراسة، الجنس، حالة الختان، الإقامة، الرضاعة الطبيعية على التوالي حسب قوة معامل الارتباط لكل متغير في النموذج المقترح. وقد تم تقسيم توصيات هذه الدراسة إلى مجموعات عمل صحية وبيئية واجتماعية واقتصادية قد تساهم في اتخاذ القرار بما يضمن استدامة صحة الطفل المصري من خلال وزن مثالي يسمح له بالمساهمة الفعالة في الإنتاج. عجلة التقدم والتقدم وتشكيل المستقبل للأجيال القادمة.

الكلمات المفتاحية: التحليل التمييزي، ويلك لامدا، السمنة، التنمية، مصر .