

# Direct and Indirect Costs Associated With Non-invasive Treatments in Obesity and Overweight Patients

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## Research article

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# Abstract

**Background:** Obesity and overweight are a global public health problem causing several chronic diseases which can lead to various degrees of morbidity and mortality. These medical conditions cause economic costs and complications. The purpose of the present study to estimate the direct and indirect costs incurred by obese and overweight patients with non-invasive treatments in Tabriz, north-western Iran.

**Methods:** The number of 247 patients were studied by cross-sectional approach and used cost of illness's prevalence approach assessing the total costs (direct and indirect) of obesity and overweight through interview and assessing relevant clinical records. The study conducted over three months from December 2018 to February 2019 in Tabriz, capital of East Azerbaijan province, Iran. Direct costs included hospitalization, para-clinical medications and outpatient visits for treatment of obesity and overweight. Loss of productivity, days of restricted activity and days in bed, cost of wasting time, transportation costs and nursing expenditure were estimated as indirect costs in the present study. For estimating direct and indirect costs, we used the bottom-up costing approach. The foreign exchange rate used in the analysis was 42000 Iranian Rial = 1US\$ (December-February 2018).

**Results:** The mean three months cost per patient is 38529697 IRR (equivalent to \$91.73 USD), Direct medical costs have a most significant part of total costs with 36765292 IRR (87.53USD) per three months (95%). Direct non-medical costs were 1380484 IRR (3.28USD) per patient (4%) and indirect costs were estimated 383981 IRR (\$0.9USD) per patient (1%). The results of the analysis of variance showed that there was a significant difference between the four strategies in three months. Among the therapeutic strategies, the most changes in body mass index (BMI) occurred in patients who used Basic diet with several types of medicines strategy ( $p < 0.001$ ). Tukey post hoc showed BMI Changes in a patient with a Basic diet with herbal remedies was minimum ( $p < 0.001$ ). According to results in the first month, BMI has a significant reduction over three months. Regarding costs, the analysis showed that Patients who used the Basic diet strategy incurred the lowest costs ( $p < 0.001$ ) and the highest costs are related to patients with a Basic diet with several types of medicines ( $p < 0.001$ ).

**Conclusions:** The results of the present study are useful in improving health policymakers and researchers in motivating to do more studies in particular for adopting new policies depending on the level of insurance coverage and their problems which patients deal with during the treatment period.

## Background:

Obesity and overweight are the conditions in which accumulation of fat in the body causes many risk factor for a number of diseases including cardiovascular diseases and diabetes, and cancer and has adverse effects on individual health status<sup>1,2</sup>. A body mass index (BMI) of 25 to  $< 30 \text{ kg/m}^2$  is defined as overweight and  $\text{BMI} \geq 30 \text{ kg/m}^2$  as obese<sup>3</sup>. Obesity constitutes a substantial threat to the global population in terms of prevalence, incidence and financial burden<sup>2</sup>. In 2018, more than two billion people, nearly 34% of the global population, were overweight or obese and 5% of the worldwide mortality are due to obesity<sup>4</sup>. If the incidence of the disease grows at this rate, almost half of the world's population will be overweight or obese by 2035. This disease imposes an enormous financial burden on the nations<sup>5</sup>. In 2015 the global economic impact of obesity was estimated to be the US \$2.0 trillion or 2.8% of the global gross domestic product<sup>6</sup>. In addition to the costs of medical care, this disease causes lost productivity and foregone economic growth as a result of lower productivity at work, lost

workdays or months, mortality and permanent disability<sup>7,8</sup>. Examining the results of recent studies showed there is a relationship between weight gain and BMI and costs attributable to obesity<sup>9</sup>.

Chronic diseases such as cardiovascular diseases, diabetes, and cancer displace infectious disease as a significant risk to individual health<sup>10</sup>. These diseases are exacerbated by increases in the prevalence of obesity and physical inactivity<sup>11</sup>. Studies on the cost of diseases help policymakers to a better understanding of the financial and economic burden of the disease<sup>12</sup>. Such cost of illness studies identifies disease complications in different parts of the population, which may have been saved if the illness did not spread<sup>13</sup>. Those studies were conducted from different perspectives that determine the types of cost included in the analysis<sup>12</sup>. These perspectives measure costs to the health care systems, society, patients and their families. The cost of illness studies have a significant role in public health in formulating health care policies and allocating health budgets by estimating total costs due to disease<sup>12,13</sup>.

In countries where the disease rate is increasing, studies are essential tools to summarizing the factors involved in the spread of disease and accurate calculations on the financial burden imposed<sup>14</sup>. The economic costs due to obesity can be burdensome<sup>15</sup>. The disease has adverse effects on individual life and affects their family conditions and public economically<sup>16</sup>. Increased social expectations and the scarcity of resources has increased the needs for health care<sup>17</sup>. In controlling disease on prioritizing resource allocation, this needs to gather information on all aspects of the disease<sup>18</sup>. A significant issue that is concerned with efficient prioritizing and allocation of resources is to quantify the effects and dimensions of the diseases and then to express them in financial or monetary term<sup>19</sup>. The study purposed to measure the direct and indirect costs expended by obese and overweight patients with non-invasive treatments in Tabriz, north-western Iran.

## Methods:

This study conducted using a bottom-up approach to identify and to calculate costs. The study was conducted for three months from December 2018 to February 2019. The number of 247 patients with obesity and overweight who were referred to medical centres in Tabriz, were studied. Present study subjects consisted of 154 females and 93 males. Due to personal problems in the third month of study, the number of thirty-two patients were excluded from the study. Finally, the study included 215 samples. Patients were followed every month for over three months. A complete history of all study subjects was taken at the starting time of the interview. Also, their medical records were considered from respective medical centres.

The study included total costs (direct and indirect) and intangible costs were not included, considering the social approach. The total costs in the present study (direct costs and indirect costs), were calculated and then analyzed by statistical software.

This study used a bottom-up approach and the total of expenditures are estimated by measuring the mean cost of obesity and overweight at first. The steps of the bottom-up approach are identifying, measuring, and valuation of resources used due to disease. In the bottom-up approach, the average of all expenses spent measured by adding together the several components of the allocated costs. A questionnaire was prepared in four parts: i) demographic information; ii) direct medical costs; iii) direct non-medical costs and iv) indirect costs. The questionnaire included 17 questions: demographic information of patients, the general health status of patients, insurance coverage, job status of patients, period of absenteeism, direct medical costs including costs of medical

visits, urgent medical services, drug, hospitalization, therapeutic strategies, direct non-medical costs, including patient and their family related to treatment and diagnosis centres, receiving complementary treatments such as herbal remedies and special diets, Patient care at home, and specific supplies. The results were calculated as the mean cost per patient for three months. We used four non-invasive treatment strategies that include basic diet, basic diet with one medicine, basic diet with several medicines and basic diet with herbal remedies. The medicines were prescribed depending on the opinion of the physicians at each stage.

## **Direct Medical Costs**

The direct medical cost included medical visits, medical laboratory tests, drug, other drugs, imaging, and consultation and four therapeutic strategies in the present study. The direct medical cost data were obtained from interviews with patients and patient's medical case records to measure the medical services or drugs that were expended. The mentioned cost items were identified and consulted by clinical guidelines.

## **Direct Non-Medical Costs**

The direct non-medical costs cover the value of non-healthcare resources like relocating, transportation costs to medical centres, other expenditures due to obesity and overweight<sup>20</sup>. For measuring direct non-medical costs, the necessary data was collected through face-to-face interviews. During the interview at the time of discharge, The demographic and first round of cost information was collected. At the starting of the study, patients had been informed about the study. Information about the costs was collected from patients. For direct non-medical costs, the average costs of accommodations per patient were calculated in for three months.

## **Indirect Costs**

The production lost due to the immobility are considered as indirect costs<sup>21</sup>. The average costs imposed on patients have been used to estimate indirect costs. Indirect costs included the cost of absenteeism during the patient period. The hospitalization period, number of days of rest and treatment at home were calculated to estimate the loss of production per patient.

## **Statistical analysis**

The data were analyzed by Statistical software (SPSS V22). Descriptive statistics were used to examine cost estimates and demographic characteristics. Due to the normality of the data, the ANOVA test was used. In the next step, due to the significance of ANOVA, to compare the costs of the strategies used the Tukey post hoc. All costs in this study are calculated first in Iranian Rials (IRR) and then presented in US dollar as per the Central Bank of Iran (1\$ = 42000IRR) exchange rate.

## **Ethical issues**

The Ethics Committee of Tabriz University of Medical Sciences issued ethical permission for the present study (IR.TBZMED.REC.1397.557). Printed informed consents were received from every patient. The study has provided full consideration and respect for privacy and the participant's personalities. Anonymity and assurance by using participants' data were exclusively secured in the study.

## **Results:**

The results were estimated in the present study showed that 32.4% of patients were covered by health insurance and 67.6% had no health insurance coverage. The mean age of the patients was 39 years. The age range of patients was 23 to 58 years. About 57% of the patients have academic education and 2.8% have primary education. Most people with obesity have diseases related to obesity, These Diseases such as diabetes (6.9% of patients), high blood pressure (22.3% of patients), fatty liver (40.9% of patients), and cardiovascular diseases (4.5% of patients). See Table 1 (demographic characteristics of the patients in the study).

Table 1  
Demographic Characteristics of the Patients in the study (N = 247)

Demographic Variables		N	Percentage
SEX	Male	93	37.3
	Female	154	62.3
AGE	17–27	55	22.3
	28–38	124	50.2
	39–49	53	21.5
	≥ 50	15	6.1
Medical insurance	YES	247	100
	NO	0	0
Type of insurance	Medical services – health insurance - rural	66	26.7
	Social Security Organization	148	59.9
	Armed Forces	28	11.3
	Imam Relief Committee and Charities	2	0.8
	Other insurances	3	1.2
Supplemental insurance	YES	80	32.4
	NO	167	67.6
Residential place	Resident	202	81.8
	Non-resident	45	18.2
Simultaneous infection with other diseases	Infection	122	49.4
	No infection	125	50.6

### Costs:

The total cost of obesity and overweight was IRR 38529697 (\$91.73) per patient in the period of study. A major proportion of total costs is direct medical costs IRR 36765292 ≈ \$87.53 (95%), direct non-medical costs were IRR 1380484 ≈ \$3.28 (4%) and indirect costs were IRR 383981 ≈ \$0.9 (1%) per patient. Direct medical costs are the largest part of total costs.

Table 2  
Table of direct and indirect costs

Costs	Min Per patient (IRR)	Max Per patient (IRR)	Mean (IRR)	Mean (\$)	Standard Deviation (IRR)
Direct medical costs	760000	10950000	3676529.2	\$87.53	1437570.6
Direct non-medical costs	0	1840000	138048.4	\$3.28	239973
Indirect Costs	0	1900000	38398.1	\$0.9	171250.4

Indirect costs we used four non-invasive therapeutic strategies that the percentage and number of user patients during the three months are displayed in table number 3. BMI Changes were compared between four therapeutic strategies in the period of study. In the strategies, basic diet with several medicines had more mean changes in the patients. By analysis of variance, there was a significant difference between the four strategies. In post-hoc Tukey Test, BMI changes in the patient by basic diet with herbal remedies was significantly less and there is also a significant difference between the strategies of basic diet with one medicine and basic diet with several medicines.

Table 3

Therapeutic strategies and percentage and number of user patients during the three months results of Tukey post hoc by  $p < 0.001$  in (N = 247)

Period of study	Therapeutic strategies	N	Percentage	P Value	Tukey post hoc
First month	1-Basic diet	39	15.8	< 0.001	2-3
	2-Basic diet with a medicine	109	44.1		1-3
	3-Basic diet with several types of medicines	97	39.3		1-2
	4-Basic diet with herbal remedies	2	0.8		-
Second month	1-Basic diet	71	28.7	< 0.001	2-3
	2-Basic diet with a medicine	77	31.2		1-3
	3-Basic diet with several types of medicines	82	32.2		1-2-4
	4-Basic diet with herbal remedies	17	6.9		3
Third month	1-Basic diet	112	45.3	< 0.001	3-4
	2-Basic diet with a medicine	40	16.2		3
	3-Basic diet with several types of medicines	22	8.9		1-2-4
	4-Basic diet with herbal remedies	41	16.6		1-3

The results of the analysis of variance indicated that there was a significant difference between the four strategies in three months. Among the therapeutic strategies, the most changes in BMI occurred in patients who used Basic diet with several types of medicines strategy. Tukey post hoc showed BMI Changes in a patient with a Basic diet with herbal remedies was minimum. Regarding costs, the analysis showed that Patients who used the Basic diet strategy incurred the lowest costs and the highest costs are related to patients with a Basic diet with several types of medicines. Table 3 showed results of Tukey Post Hoc for each month.

According to Fig. 1, in the first month, BMI has a significant reduction over three months. This reduction in the first month can prevent further direct and indirect costs in the next following two months.

In the analysis, the costs in reducing one unit of BMI by therapeutic strategies We found that in the first month of study by Basic diet strategy Reducing a unit of BMI is a less expensive and Basic diet with one medicine in a long time was more economical. Table 4 illustrates the average changes in BMI and total costs for a unit of BMI change in the first month and a total period of study.

Table 4  
Costs analysis of strategies in relation to changes of BMI

Therapeutic strategies	Average changes of BMI		Average Total Costs(TC) (IRR)		TC ÷ BMI (IRR)	
	First month	Total period	First month	Total period	First month	Total period
Basic diet	0.64	0.49	2863589.7	3161985.3	4474358.9	6453031.2
			IRR	IRR	IRR	IRR
			(\$68.18)	(\$75.28)	(\$106.5)	(\$153.64)
Basic diet	0.84	0.64	3841889.9	3954011.4	4573678.4	6178142.8
with one			IRR	IRR	IRR	IRR
medicine			(\$91.47)	(\$94.14)	(\$108.89)	(\$147)
Basic diet	1.25	0.82	5651422.6	5386133.0	4521138.0	6568454.8
with several			IRR	IRR	IRR	IRR
medicines			(\$134.5)	(\$128.2)	(\$107.6)	(\$156.3)
Basic diet	0.43	0.40	4407500	4005025.0	10250000	10012562.5
with herbal			IRR	IRR	IRR	IRR
remedies			(\$104.9)	(\$95.3)	(\$244)	(\$238.3)

## Discussion:

Overweight and obesity growth is a major public health challenge in the present century<sup>22</sup>. Currently, about 30% of the world's population and 20% of Iranian are obese, while 5% of the world's deaths are due to obesity<sup>23</sup>. This

study estimates the costs attributable to the overweight and obese population in Tabriz using BMI over a period of three months. Obesity has several economic effects. Diseases caused by obesity multiply the cost of treatment.

The direct medical costs accounted for 95% of the direct costs and these costs are a large part of the total costs. These results are correlated with other studies that estimated the costs of obesity and overweight in several countries reported the direct costs to account for about 85–90% of total costs<sup>24</sup>. In the present study, the most direct medical costs are related to medical interventions (80%). In the study, first-month costs accounted for the main direct non-medical costs. Increasing the total costs due to the prices of medicines and medical supplies are the issues that should be paid to health and planning officials. The more costs were not covered by insurance and these increased costs can be affecting in access and demand for medical cares for patients. In the calculations of the results of the present study, indirect costs included 1% of the total costs, which is correlated with other conducted studies. More than 75% of the indirect costs of the study were due to absenteeism in the period of the disease.

A study estimated that incremental obesity-related direct medical costs were a total of \$152 billion annually in the USA (\$2009), which corresponds to 9.1% of National Health Expenditure Account spending<sup>25</sup>. Moreover, it can be said that direct medical costs due to disease have increased significantly with the increase in obesity and overweight. Annual direct medical costs of obesity during 2006 were \$151.7 billion, which is double the amount of disease spending between 1997 to 1998. Increased prevalence of obesity rather than the increased costs of obesity-related care is the main factor of driving the trend in obesity-related direct medical expenditures. The current study has supported the existing finding. Calculations show that these costs will increase in the future. Forecasting future costs of obesity using obesity prevalence from the National Health and Nutrition Examination Survey's results suggest that direct costs attributable to obesity could double from 2010 to 2020 and account for 15.8% – 17.6% of national health care expenditures in 2030<sup>25</sup>. Reviewing the results of calculations of studies conducted in this field showed health care costs are rising dramatically with weight, which means costs for obese people spend much more on health care than overweight or moderately obese individuals<sup>25</sup>. Arterburn et al. estimated the health care costs for a morbidly obese person are \$2,845 higher per year than the healthcare costs for an average-weight person and the health care costs for an overweight person are \$346 higher per year than the health care costs for an average weight person<sup>26</sup>.

Retirement age is an important and influential factor in calculating indirect costs (productivity loss), which varies from country to country. In different retirement age thresholds in various countries, there are different values of indirect costs. The age at which obesity and overweight start is an important point. Higher the age of start, the less the productivity is lost. With the improvements made in medical technologies and the availability of interventions in obesity and overweight patients increase the total cost of treatment and especially the direct costs. Also, medical techniques reduce the mortality at low age and consequently reduce the indirect costs. The mentioned improvements may lead to an increasing share of absenteeism expenditure. Health insurance usually covers direct medical expenses, but health insurance schemes do not cover indirect costs. By expanding health insurance coverage in the healthcare centres, And developing methods and facilities for treating the disease, It may reduce the financial burden imposed on families<sup>19</sup>.

According to Fig. 1, in the first month, BMI has a significant reduction over three months. This reduction in the first month can prevent further direct and indirect costs in the next following two months. According to the present study, the most changes in BMI occurred in the first month. According to the theories of nutrition experts, these

changes were expected in a month<sup>26</sup>. Due to racial, cultural and social differences, patients do not follow medical advice completely, which itself can challenge the results of the present study. According to the study by Paola Bully et al., the BMI changes were significant among females. This gender difference shows that medical interventions in females can be better achieved<sup>29</sup>.

The study indicates that female had a higher percentage of obesity and overweight. Most of them were housewives and lived with a sedentary lifestyle. It is determined by a brief look at the results of the studies the growth of obesity and overweight will come at a high cost in health and economy. The relationship between obesity and mobility is inverse. According to this principle that Creating a culture of mobility and exercise can help reduce costs. The immobility of obese patients can have negative consequences for a country's economy in addition to medical expenses. In today's society, the issue of obesity and overweight children is very prominent; even children's games have changed due to the necessary mobility in children. The rise of mass media has led to an increase in obesity unfortunately<sup>28</sup>.

The first step in this regard is to make people aware of the costs associated with obesity and overweight. It will be possible to estimate the costs with such further studies. Governments should encourage people to diet better and sport and expanding health insurance that reduce costs.

We encountered problems during the study, such as lack of desire to report accurate personal information. In the present study, information about medical centres was self-reported, and it can be personal biased. The results of many studies have shown that when comparing self-reported data to medical or administrative data on health services utilization that patients tend to underestimate their utilization. Self-reported indicator of health problems, including disability in the current study could be a problem a three-month period can lead to an underestimation of the length and the frequency of the episodes of severe problems. The results confirm that similar to the results of studies conducted worldwide; there are important economic consequences associated with overweight and obesity in study s patients. These types of studies may be tools to support policymaking processes and guide the allocation of resources for obesity prevention. Due to racial, cultural and social differences around the world that more studies are essential in this regard.

This study estimates obesity and overweight costs by social approach. These results provide useful and applied information for decision-makers and health principles about the economic burden and components of total costs per patient. For validate and accurate evidence to the scientific literature, systematic methodology included a broader perspective, a bottom-up measuring method, follow-up of patients for three months and interview with patients every month. Despite mentioned benefits, this study may suffer from some limitations, such as the conservatism of patients in stating total costs, and due to recall bias the probability of human error in reporting costs and non-randomness of selected samples. Using the cases and medical records of patients in the health centres and interviewing with the patients, some of these undesired limitations were resolved.

## **Conclusion:**

The study results showed that obesity and overweight are high-cost diseases that may cause a significant financial burden on patients and families, primarily due to increasing needs to receive more costly medical interventions. The amount of costs imposed on obese and overweight patients in Tabriz was very high and is increasing, while their income is decreasing. The results of the present study showed that for reducing these costs, increase health insurance coverage and assistance from the country's health care system is necessary, and useful

steps including exempting the low-income sections of society from diagnosis and other stages of treatment, coverage of drugs expended for these patients in public health centres and treatment costs. With these preventive policies, these diseases will lead to saving and thus public health system will be able to improve the conditions of the country. The results of this study may pave the way for Iranian healthcare managers and policymakers to be used to conduct financial burden analysis for obesity and overweight prevention programs.

## **Declarations:**

### ***Ethics approval and consent to participate:***

The study has received ethical permission from the Ethics Committee of Tabriz University of Medical Sciences (IR.TBZMED.REC.1397.557). Printed informed consents were received from every participant. The study has provided full consideration and respect to privacy and participant's personalities. Anonymity and assurance by using participants' data were exclusively secured in the study.

### ***Consent for publication:***

Not applicable.

### ***Availability of data and materials:***

The study data are available and will send to made accessible by Dr Ali Imani (Email:imania@tbzmed.ac.ir).

### ***Competing interests:***

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### ***Authors' Contributions:***

All authors have read and approved the manuscript.

SM: literature review, proposal writing, data collection, data analyzing, article writing

MG: literature review, article writing

MA: data collection

AI: proposal writing, data collection, data analyzing, article writing, same joint role of corresponding author.

KD: article writing, data analyzing, critical review

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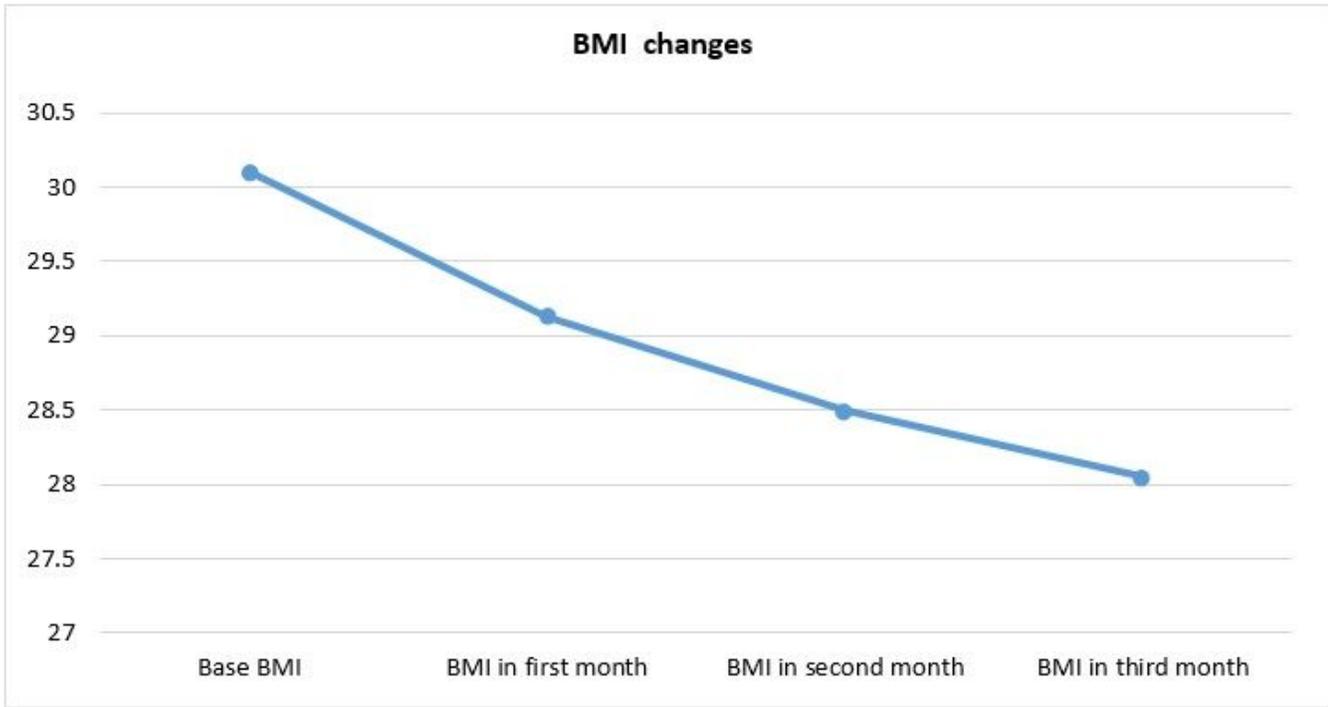
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## Figures



**Figure 1**

changes of BMI in before and during the study