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## The Cluster Analysis, BMI Status and Dietary Habits of the Patients with Thyroid Disorder in Pakpattan, Pakistan

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**Abstract:** Thyroid gland is one of the important glands in human body and thyroid disorder creates many serious health problems. The present work is based on the study of 200 individuals (57 male and 143 female) with thyroid disorder (i.e., goiterous patients) from Pakpattan, Pakistan. The said study explores the dietary habits, Body Mass Index (BMI) status and cluster analysis of these patients.

**Key words:** BMI, goiter, iodine deficiency disorder, thyroid disorder

### INTRODUCTION

Thyroid is an important endocrine gland in human body. The main function of the thyroid gland is to synthesis thyroid hormones which are essential for the regulation of metabolic process throughout the body. Thyroid hormone plays its role in cellular metabolism, growth and development. Thyroid glands are butterfly shaped and are located at the lower front of neck (Dunn, 1998). Thyroid hormones are of two kinds Thyroxine (T4) and Triiodothyronine (T3). They increase cellular metabolic activity, basal metabolic rate, active transport of ions through cell membrane and increase number and activity of mitochondria (Ladenson, 2000). Moreover, according to Hermus (1998), the thyroid hormones affect the brain development and skeletal maturation.

Among all the clinical thyroid disorders, goiter is the most visible and important. Goiter is a slowly developing diffuse or nodular enlargement of thyroid gland due to an excessive replication of follicular epithelium with subsequent generation of new follicles of widely differing structure and function. It may result from hormonal and immunological stimulation of gland growth or the presence of inflammatory proliferative and metabolic disorders (Langer, 1999).

Iodine is an essential element needed by both human being and animals. Human needs iodine to make thyroid hormone. These hormones are produced by thyroid gland. After formation it travels to the blood. These hormones are essential for normal development of human brain and nervous system. When people don't have enough iodine they cannot make enough thyroid hormone. This deficiency has several important health hazards and collectively called Iodine Deficiency Disorder (IDD). The consequences of IDD result in goiter (enlargement of thyroid gland) hypothyroidism, cretinism, deaf mutism, short stature, reproductive failure, increase maternal and childhood mortality (Stanbury *et al.*, 1980).

The lack of dietary iodine is an important underlying cause of thyroid disorders. However, excess iodine, genetic background, other geographical and dietary factors can trigger thyroid disorders (Knudsen *et al.*, 2002). Therefore, the knowledge of the thyroid disease is important in order to avoid the adverse effects of the disease and to take all the respective precautionary measures.

A number of international studies can be found on the thyroid disorder, its consequences and precautionary measures (e.g., Day *et al.*, 2003; Hoogendoorn *et al.*, 2006; Knudsen *et al.*, 2002; Nieuwland, 1992 etc. among many others). However, very few such studies have been carried out in Pakistan, for example, Bukhari *et al.* (2008), Hussain *et al.* (1994), Iftikhar *et al.* (2011) and Zuberi *et al.* (2004) etc. Among these studies, Hussain *et al.* (1994) worked on the Northern Hindukush mountainous belt of Pakistan that is among the most affected areas of IDD. It was reported that 70% of the estimated 8.8 million population was at risk of IDD (at that time). Zuberi *et al.* (2004) assessed the clinical presentation of patients with thyroid cancer and concluded that the thyroid cancer was emerging as an aggressive disease in Pakistan. Iftikhar *et al.* (2011) carried out a preliminary investigation in the province of Baluchistan regarding thyroid cancer and radioiodine therapy. They concluded that the incidence thyroid cancer was due to lack of education and health care facilities.

The present work contains an explorative study of the patients with thyroid disorder in the rural areas and suburbs of a city of Punjab, Pakpattan. The reason to select this area is the exceptionally large number of goiterous patients. A questionnaire-based sample survey was conducted to study the prevalence of thyroid disease. To do this, we have selected 200 patients (57 male and 143 female) of goiter from the said area.

**MATERIALS AND METHODS**

The current study is actually a case study of rural areas of Pakpattan, a city of the province Punjab. Therefore, the target population is the population of the people of Pakpattan with thyroid disorder. An arbitrary sample of size 200 is proposed while the suitable sample technique is the purposive sampling (Bukhari *et al.*, 2008 and Iftikhar *et al.*, 2011 for the similar sampling techniques and sample sizes).

The data were obtained through a self-administered questionnaire during April to August, 2011. The obtained data were about the age (in years, rounded to next year) of the respondent, height, weight, size of the goiter, goiter grading, diastolic and systolic blood pressure, marital status, education, profession, monthly family income, use of dairy products, meat, pulses/cereals, vegetables, fruit and spices, sources of drinking water and fuel for cooking and the types of treatment for the thyroid disorder.

There are many ways to determine if a person is obese but a person's Body Mass Index (BMI), defined as the ratio of weight (kg) to squared height (m<sup>2</sup>), has been popularly used as a measure of overweight and obesity. A person is said to be "underweight" if BMI ≤ 19; "normal" if 20 ≤ BMI < 25; "overweight" if BMI > 25 and "obese" if BMI > 30. We obtain the BMI status of all the patients, under study, with thyroid disorder.

For graphical presentation, we use pie charts for different comparisons. Some cross-tabulations have been used for different attributes, along with the respective cell-percentages. The Chi-square statistic is computed (where applicable) to assess the association between the two attributes at the nominal level of significance i.e., 5%.

Identifying groups of individuals or objects that are similar to each other but different from individuals in other groups can be intellectually satisfying, profitable, or sometimes both. We can take advantage of these similarities to target offers to subgroups that are most likely to be receptive to them. Based on the BMI, goiter size and goiter grading, we cluster the patients into subgroups that have similar response patterns. This may help us in targeting appropriate treatment and studying typologies of diseases. Using cluster analysis, we can also form groups of related variables, similar to what we do in factor analysis. There are numerous ways we can sort cases into groups. In our case, we use two-step clusters (Romesburg, 2004 for more details).

**RESULTS AND DISCUSSION**

In our data set of 200 patients with thyroid disorder, 57 (28.50%) are males while 143 (71.50%) are females. Moreover, among these 200 respondents, 103 (51.50%) are unmarried and 97 (48.50%) are married. The mean age of the patients is 26.68 ± 14.37 (Mean ± SD) years. The mean weight of the patients is 51.15 ± 13.56 Kg.

while the average height is 61.95 ± 5.28 inches. Similarly, the average BMI for all the patients under study is noted to be 20.65 ± 5.07. The average BMI shows normal body weight. The mean diastolic blood pressure is noted to be 83.35 ± 14.37 while the mean figure for the diastolic blood pressure is 125.77 ± 22.77. These figures range to normal level of blood pressure, on the average.

A significant majority (44%) of the patients is completely uneducated while 48% of the patients have matriculation or below level of education. Only 8% of the patients have passed their intermediate or high level of education.

The monthly family income of the respondents is reported to be Rs. 7692 ± 3833. It is further reported that for majority of the respondents, the monthly family income is between Rs. 5,000 and Rs. 10,000. Only, 2% of the respondents have monthly family income greater than Rs. 20,000. It shows that majority of the patients in Pakpattan belong to poor economical class. As much as 58% of the patients have no proper profession while there are 3% each of the daily wagers, job holders and owning business. Twenty two percent of the patients are students.

One of the objectives of the present study is to explore the dietary habits of the patients with thyroid disorder. Table 1 expresses the distribution of the patients, based on their diet. It is noted that a majority of the patients take milk and ghee on daily basis. It is because the patients belong to the rural areas or suburbs where it is very common to use milk and ghee. The patients, under study, mostly use chicken and beef on weekly basis. The daily use of meat is rare and 98% of the patients do not use fish in their meals. Majority of the patients (95.5%) use vegetables on daily basis.

When the data are collected about the use of salt and other spices, it is noted that about 75% of the patients with thyroid disorder still do not use iodized salt in their foods which may be one of the major causes of goiter. As for as other spices are concerned, more than 88% of the patients use turmeric powder and 99% use black pepper in their daily foods.

Table 1: Dietary intake

Diet classification	Use		
	No	Daily	Once or twice in a week
<b>Dairy items</b>			
Milk	11 (5.5)	97 (48.5)	92 (46.0)
Yogurt	111 (55.5)	23 (11.0)	66 (33.5)
Butter	156 (78.0)	15 (7.5)	29 (14.5)
Ghee	1 (0.5)	198 (99.0)	1 (0.5)
<b>Meat</b>			
Chicken	11 (5.5)	3 (1.5)	186 (93.0)
Beef	54 (27.0)	1 (0.5)	145 (72.5)
Mutton	123 (61.5)	1 (0.5)	76 (38.0)
Fish	196 (98.0)	0 (0.0)	4 (2.0)
Pulses/cereals	0 (0.0)	16 (8.0)	184 (92.0)
<b>Vegetables and fruit</b>			
Vegetables	0 (0.0)	191 (95.5)	9 (4.5)
Fruit	2 (1.0)	6 (3.0)	192 (96.0)

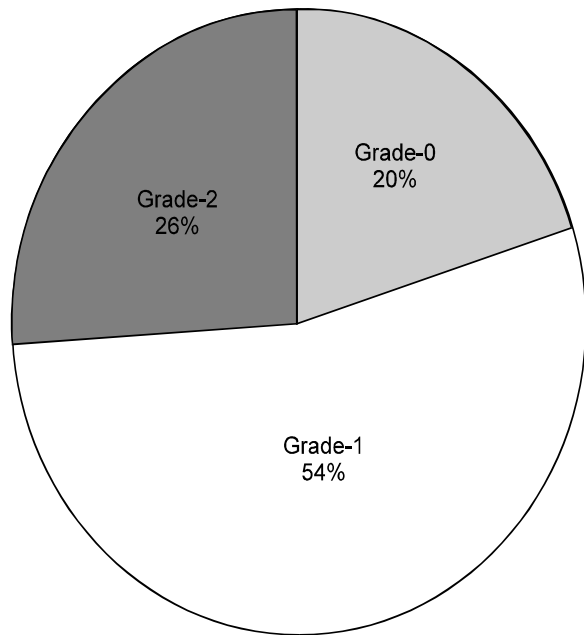


Fig. 1: Goiter grading

The major source of drinking water for the respondents is hand pump. As much as 93% of the patient use drinking water obtained from the hand pumps, usually, fitted in their home courtyard. However, the drinking water is also obtained from tube-well and water tanks by the 4 and 3% of the respondents, respectively. It is noted that, in the said area of Pakpattan, there is no filtration plant for drinking water or any other source of some treated water.

When the source of fuel for cooking is inquired, it is noted in more than 85% of the homes to which the respondents belong, woods are used for cooking. There is almost non-availability of natural gas. After woods, the second prominent source of fuel is cotton stick.

Among the goiterous patients, 24.0 % have goiters of small size while the percentages of mild, big and very big goiter sizes are 47.5, 22.0 and 6.5%, respectively. So the majority of the patients have goiter of mild size.

In the present study, goiter is screened by palpation method and is graded as per definition provided by WHO/UNICEF/ICCIDD (2007). The grading is described as Grade-0, no palpable or visible goiter; Grade-1, goiter that is palpable but not visible when the neck is in the normal position; and Grade-2, visible when the neck is in the normal position (Das *et al.*, 2011). Figure 1 shows that majority of the patients (54%) have goiter of Grade-1 while 26 and 20% have Grade-2 and Grade-0 goiter, respectively. Thus, more than half of the patients have the palpable goiter that is not visible when the neck is in the normal position.

Figure 2 displays the obesity status of the goiterous patients. It is found that majority of the goiterous patients

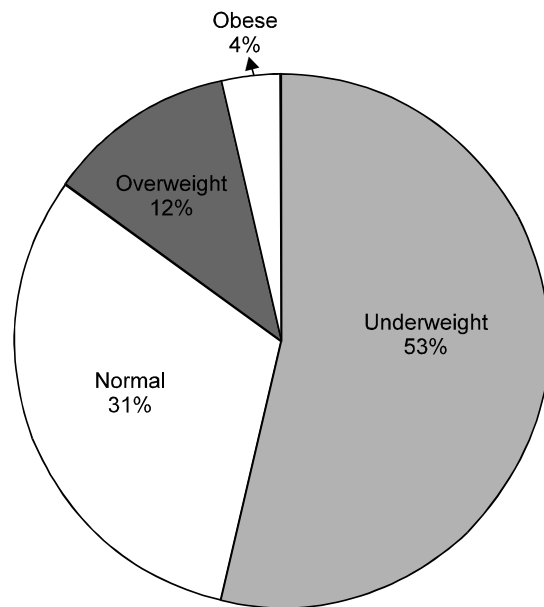


Fig. 1: Goiter grading

Table 2: Gender and goiter grading

Gender	Goiter grading			Total
	2	1	0	
Male	16 (28.07)	34 (59.65)	7 (12.28)	57 (28.50)
Female	35 (24.48)	75 (52.45)	33 (23.07)	143 (71.50)
Total	51 (25.50)	109 (54.50)	40 (20)	200

(53%) are underweight while 31, 12 and 4% are normal, overweight and obese, respectively. These results also seem to be consistent with the dietary habits of the patients.

When the patients are asked about the treatment of the thyroid disorder, it is found that 19% of the patients do not take any treatment while 40% rely just on "dam-durood" for recovery. Only 29% of the patients are being treated by allopathic medicines while 7 and 5% by homeopathy and hikmat, respectively. The findings also show an agreement with low education level and poor socio-economic conditions of the patients.

Table 2 displays the frequencies (and respective percentages in parentheses) of the goiterous patients w.r.t. their gender. No association is found between the gender and goiter grading for  $\chi^2_{\text{cal}} = 2.970$  with df 2 and p-value = 0.227. However, the percentage of females with Grade-1 goiter is almost double than that of males. According to Table 3, there is no association between the obesity level and goiter grading for  $\chi^2_{\text{cal}} = 6.47$  with d.f 4 and p-value = 0.167. Due to fewer observations of obese patients, we have combined the overweight and obese patients. Similarly, no association has been reported between the obesity status and the goiter size of the patients.

For cluster analysis, the goiterous patients are distributed w.r.t. their BMI and goiter grading. It is

Table 3: Obesity level and goiter grading

Obesity level	Goiter grading			Total
	2	1	0	
Underweight	34 (31.78)	52 (48.60)	21 (19.62)	107 (53.5)
Normal	11 (17.46)	41 (65.08)	11 (17.46)	63 (31.5)
Overweight/obese	6 (20.00)	16 (53.33)	8 (26.67)	30 (15.00)
Total	51 (25.5)	109 (54.5)	40 (20)	200 (0.00)

Table 4: Cluster distribution and cluster profiles (BMI centroids)

Cluster	N	% of Combined	BMI	
			Mean	SD
1	109	54.5	20.81	4.21
2	40	20.0	21.04	5.21
3	51	25.5	19.99	6.50
Combined	200	100.0	20.65	5.07

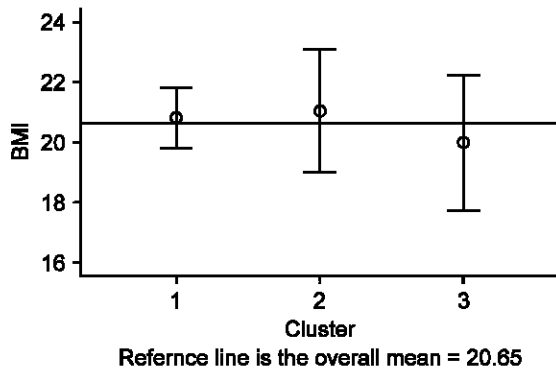


Fig. 3: Simultaneous 95% confidence intervals for means

reported that there are mainly three clusters. According to Table 4, majority of the patients (54.5%) falls in Cluster 1 with the BMI centroid, 20.81±4.21. On the other hand, the patients lying in Cluster 2 have the average BMI, 21.04±5.2. Moreover, 25% of the patients (Cluster 3) carry near to underweight status. It is also noted that all the patients in Cluster 1 have goiter of Grade-1, all the patients of Cluster 2 have goiter on Grade-0 and all the patients of Cluster 3 have goiter of Grade-2. Figure 3 displays the simultaneous 95% confidence intervals for means of BMI in different clusters. The figure shows the highest variation in Cluster 3 w.r.t. BMI. It is also depicted from the figure that the average BMI is above 20 for clusters 1 and 2 while below 20 for Cluster 3. Therefore, it is reported that the patients with goiter of Grade 2 have, generally, an underweight status and have large variations in their BMIs.

**Conclusions:** The present study has focused on the patients, belonging to Pakpattan, with thyroid disorder. For these patients, different demographic characteristics, their dietary habits and BMI status have been studied. It was found that more than 70% of the patients are females and almost half of the total patients

are married. The mean age of the patients is 26.68±14.37 years. The average BMI for all the patients under study is reported to be 20.65±5.07 that reflects a normal body weight. However, it was concluded that the majority of the patients are underweight, having BMI less than 19. This fact, basically, leads toward the dietary habit of the patients and their poor economical conditions. Mostly patients use vegetables in their daily meals while they take meat on weekly basis. It is reported that 75% of the patients with thyroid disorder do not use iodized salt in their foods even after having the disease. The main reason is the lack of awareness and education. A significant majority (44%) of the patients are completely uneducated while 48% have matriculation or below level of education.

The monthly family income of the respondents is reported to be Rs. 7692±3833 and it is found that majority of the patients belong to poor families. The major source of drinking water is hand-pump and fuel source for cooking is woods. It is found that majority of the patients have goiter of mild size while most of the patients have goiter of Grade-1 (i.e., the goiter is palpable but not visible when the neck is in the normal position). Among these goiterous patients, 19% of the patients do not take any treatment for thyroid disorder while only 29% of the patients are being treated by allopathic medicines. It is also concluded that there is no association between the goiter grading or size and gender. That is male patients have the similar likelihood to have same grade or size of goiter as the female patients have. Similarly, no associations have been found between the obesity level and goiter grading or size. Finally, through cluster analysis, it is concluded that more than 50% of the patients fall in cluster 1 having goiter of grade-1 with the average BMI 20.81±4.21.

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