https://doi.org/10.46389/rjd-2024-1444
www.rjdnmd.org

Rom J Diabetes Nutr Metab Dis
2024; volume 31, issue 2, pages 150–157

Original Article

# Association between awareness of the updated food label and both anthropometric and biochemical measurements among patients with type 2 diabetes in Jordan

**Aseel Tayseer Al-Shawabkeh [1], Mohammed Omar Ibrahim [1] ***

[1] Department of Nutrition and Food Technology, Faculty of Agriculture, Mu'tah University, Karak, Jordan

* Correspondence to: Mohammed Omar Ibrahim, Department of Nutrition and Food Technology, Faculty of Agriculture, Mu'tah University, Karak, Jordan. Phone: +962778039295; E-mail: mohammedomar@mutah.edu.jo

Received: 17 November 2023/ Accepted: 28 March 2024

## Abstract

Nutrition label is one of the crucial tools that are highly recommended for patients with Type 2 Diabetes Mellitus T2DM. The aim of this study was to determine the association between food label awareness and their anthropometric and biochemical parameters. A cross-sectional study was conducted using a questionnaire included information regarding sociodemographic, anthropometric, and biochemical data. Study participants were recruited from T2DM patients in Diabetes Clinics in Madaba City and Al-Bashir Hospital in Amman. Results of the study indicated that food label awareness among T2DM patients were severely low within the score (2 out of 8) among Jordanian T2DM patients. Patients that practicing sports, smoking, having higher monthly incomes, and having higher educational levels, have shown a significant higher food labelling awareness. Body mass index (BMI) and females' waist circumference (WC) negatively correlated with food label awareness, while male WC was not correlated with food label awareness. Food label awareness was negatively correlated with high HbA1c and FBS (mean=8.84, 212.85, respectively) among T2DM patients. It was concluded from the study that Poor nutrition awareness be a barrier to diabetes control, thus the reinforcement of nutrition awareness is beneficial in understanding food labeling and guiding patients to choose healthier foods.

**Keywords:** type 2 diabetes mellitus, food label, nutrition awareness.

## Introduction

The importance of the food label is because it contains the ingredients of the product and the nutrients and percentages of daily values for nutrients it contains [1]. Food labels supply information about daily values, calories, and the contents of nutrients involves carbohydrates, fats, saturated fatty acids, proteins, sugars, sodium, vitamins, and minerals [2]. Food labels contain useful information about food products and can be considered as identity cards, therefore food labels allow the consumer to consciously pick out what to buy and make a final decision [3]. Food label must be comprehensible and clear to the consumers because the purpose of the food label is to increase consumer awareness about the product, its ingredients, and the nutrients it contains [1, 4]. Studies found that awareness of food label significantly affects dietary practices, especially if the consumers suffer from noncommunicable diseases (NCDs) [5].

Chronic diseases correlated to inadequate and poor dietary habits are the most crucial challenges of the modern era [6]. Thus, international organizations encourage people to adopt healthy eating habits and use food labels to choose products that are appropriate for their health status [5]. Depending on the association between chronic diseases and poor nutritional habits, it is needful for chronic disease patients to be aware of nutrition labels and follow nutritional guidelines [7].

Diabetes Mellitus (DM) is one of the chronic diseases that remains a considerable global health problem

[8]. Diabetes and metabolic syndrome are nutrition-related health issues that have a considerable impact on society [9]. DM is a chronic disease characterized by either the pancreas not producing sufficient insulin or the body cannot productively use the insulin it produces [10]. DM is a metabolic disease that is distinguished by hyperglycemia correlated with modifications in carbohydrate, protein, and fat metabolism, all of which conduct destructive complications for a patient, decreasing life expectancy and quality of life [11]. Nearly half of type 2 diabetics are obese, due to the accumulation of fat that causes insulin resistance, while the others have a healthy body mass index (BMI) [12].

The appropriate management of diabetic patients particularly patients with Type 2 diabetes mellitus (T2DM), requires appropriate eating habits and a healthy lifestyle. Awareness of food labels is affected by nutritional knowledge and health literacy. Awareness is a significant issue to manage T2DM. In Jordan, Ajlouni *et al*. [13] reported that the prevalence of T2DM was 23.7%. Therefore, the aim of the study was to assess consumer understanding of nutrition labels on dietary habits among T2DM patients, to examine food label awareness in T2DM Jordanian patients, to recognize the influence of the updated food label on T2DM patients, and to determine the association between food label awareness and anthropometric, and biochemical parameters among T2DM patients in Jordan.

## Material and methods

### Study design and criteria

The present study used a cross-sectional study design. Participants were patients with T2DM in Diabetes Clinics in Madaba City and Al-Bashir Hospital in Amman of the Jordanian Ministry of Health. This study was conducted in a convenience sample of 417 Jordanian Patients with T2DM. Inclusion criteria require participants above the age of 18 years. Exclusion criteria were implemented for participants under 18 years old or pregnant and breastfeeding participants. Moreover, diabetic patients with severe health conditions such as self-reported cancer, liver disease, and kidney failure were excluded from the study.

### Sample size and sampling techniques

Sample size calculation using the G-Power program for calculating the minimal sample size, with a 95% level of significance (α=0.05) and settings power of 80%, the minimal sample size needed with inferential statistics used the sample size was 417.

### Study site

The study was conducted in Amman city and Madaba city in Jordan. Amman is the capital of Jordan and located at longitude 35, 56 degrees east, latitude 31, and 56 degrees north. Meanwhile Madaba city is located at longitude 35, 48 degrees east, latitude 31, and 43 degrees north.

### Data collection

The questionnaire as a data collection tool was designed after defining the research objectives and their questions related directly to the research problem. A structured questionnaire was developed based on questionnaires used in previous studies [14, 15]. The primary version of the questionnaire was sent to academic arbitrators who are experienced in the current field of study from the Department of Nutrition and Food Technology at Muta'h University to verify the validity of the study instrument and to manifest their opinions about the questionnaire items, the suitability. Based on the agreement of the arbitrators, the questionnaire was modified and applied. The information about patients was collected face to face through the questionnaire that included (31) questions and categorized into four sections. The four sections were: (1) Demographic characteristics, (2) Anthropometric characteristics, (3) Biochemical characteristics, (4) Awareness of food labels.

**1. Socio-demographic characteristics**

Socio-Demographic data were obtained from patients' answers to the questions regarding age, gender, marital status, education level, monthly income, smoking, practicing sports, and diet.

**2. Anthropometric characteristics**

The anthropometric characteristics in this part included questions about weight in kilograms (kg), height in centimeters (cm), body mass index (BMI), and waist circumference (WC) in centimeters (cm). Height was measured with the patient standing without shoes with a tape measure. The weight of the patient was measured in light clothing, using a weight scale. BMI was calculated by dividing the patient weight in kilograms (kg) by the square of the height of the patient in meters (m). BMI was classified according to the WHO [16] cut-off points for adults as follows: underweight,

≤18.5 kg/m², normal weight 18.5–24.9 kg/m², pre-obesity 25–29.9 kg/m², obesity ≥30 kg/m². WC was measured at the midpoint between the lower margin of the last palpable rib and the top of the iliac using flexible but non-stretchable tape [17]. All anthropometric measurements have been calculated according to the WHO anthropometric cutoff used to classify WC for men (≤/>94 cm) and women (≤/>80 cm) [18].

**3. Biochemical characteristics**

All biochemical variables including (fasting blood sugar (FBS), glycated hemoglobin (HbA1c), total cholesterol (TC), low-density lipoproteins (LDL), high-density lipoproteins (HDL), Triglyceride (TG), iron serum, ferritin) were measured for patients involved in the current study. In both diabetes clinics in Madaba and Al Bashir Hospital in Amman, patient's examination information was obtained from Hakeem system of the Jordanian Ministry of Health, where the patient's examination information of each patient separately was obtained by entering the Hakeem system through the national number. Hakeem system is one of the electronic health systems applied in Jordan to contribute to the health care and services of medical sectors by connecting public health hospitals all around Jordan [19].

**4. Awareness of food labels**

The fourth section of the questionnaire was dedicated to determining the consumers' awareness of nutrition facts labels. Therefore, to determine a patient's food labeling awareness level, each question includes two values; a (0) value assigned for a (no) response, and a (1) value assigned for a (yes) response. The total score was from eight computed by summing all eight questions, a higher value indicates a high level of patient awareness. The question "Do you always buy prepackaged food?" was not counted among the total scores; it did not include vocabulary indicating awareness as reading or understanding, but it was written within this section because many prepackaged foods contain sweeteners that may affect blood sugar.

## Data analysis

All data were processed using Excel Microsoft programs and the statistical package for social science (SPSS version 28). Descriptive statistics were applied to describe the demographic characteristics, socioeconomic characteristics, anthropometric characteristics, and biochemical measurements of participants. Frequencies and percentages were used for the categorical variables, and the continuous variables were expressed as mean±standard deviation (SD). For non-parametric, Mann-Whitney U test was used for independent variables having two levels and achieved homogeneity assumption namely (Gender, Marital status, Practicing sports, following a certain diet, and smoking status) while Welch one-way ANOVA test was used for independent variables having three or more levels and did not achieve normality and homogeneity assumptions as well. The significant results were followed by Games-Howell test as a post hoc test for family pairwise comparisons. Spearman rank correlation ρ was applied to measure the relationship between food label awareness and anthropometric and blood glucose measurements The Point-biserial was applied to measure the correlation between food label awareness and anthropometric measurements of WC for males and females. A p-value set at <0.05 is considered statically significant.

## Results

The majority of participants were female (65.9%), married (89.9%), aged group between 39–59 (45.6%), and with a monthly income category between 100–400 JOD (79.2%). About one-third of the sample had a primary education level followed by participants with primary education level (30.9%).The majority of participants were not smokers (79.3%) and were not practice sports (61.8%). The majority of participants had BMI ≥30 (57.1%). About three-quarters of male participants have a WC >94cm, whereas 93.7% of female participants have a WC >80cm.

Several biochemical investigations have been obtained for T2DM patients. Mean FBS and mean HbA1c were (212.85mg/dl and 8.84, respectively), indicating that the patients did not reach the normal range of FBS and HbA1c. Regarding patients' lipid profiles, the mean TC among diabetic patients was 181.94 mg/dl, which considered within the normal range. The LDL mean level slightly tended to be high >100 mg/dl and the HDL mean was found to be 42.05 mg/dl which considered within acceptable range but not in the desired level. The mean TG found to be 133.62 mg/dl, which considered within the normal range. Moreover, the mean serum iron and mean ferritin were within the normal ranges.

Results in Table 1 have shown that (66.4%) of patients did not read the nutritional facts on the products before buying them and (67.7%) did not look at the nutritional guidelines before making the purchase. Moreover, more than half of the sample (54.8%) did not


https://doi.org/10.46389/rjd-2024-1444

understand the information displayed on nutritional labels and (68.2%) of patients didn't know the meaning of nutrients on the food label. About (60.4%) of the sample had buying decisions that didn't influence by nutritional information on products. In addition, (52.1%) didn't believe that food labels can affect positively nutritional awareness. Likewise, a large percentage of patients did not read food labels on prepackaged items and did not know to calculate their grams intake (84.8% and 97.7% respectively). The mean and the median for scale score were computed to be (2.48 and 2 out of 8, respectively), indicating that the patients have severely low awareness levels toward food labeling.

The results in Table 2 revealed that patients performing practicing sports significantly have a higher food labeling awareness level than those who did not practicing sports (U=4211.5, p-value=0.002). Likewise, smoker patients significantly have a higher food labeling awareness level than non-smokers (U=2739.0, p-value=0.002) while neither patients' gender, marital status nor following certain diets have shown statistically significant differences in food label awareness score. Regarding patients' monthly income, the results have shown statistically significant differences with (Welch=9.485, p-value=0.002). The Games-Howell test has shown that those with an income level of <100/JOD significantly had a lower mean food labeling awareness score than those earn 100–400JOD/month (p-value=0.043). Participants with monthly income >400JOD/month were significantly had a higher mean food labeling awareness score than those earn <100/JOD and 100–400JOD/month (p-value=0.002, p-value=0.027 respectively).In the same context, results of patient's age have shown a significant differences in the mean score of awareness (Welch=7.654, p-value=0.001). Age group 39–59 years old significantly had higher mean of awareness score than those in the age group 60–80 years old (p-value=0.001), while no significant Mean difference was detected between the age group of 18–38 years old with 39–59 years old and 60–80 years old, (p-value=0.518, and p-value=0.175 respectively). Finally, the diabetic patient's education level has a significant effect on the food labeling awareness level (Welch=24.360, p-value <0.001) revealing that those holding University degrees significantly had a higher mean food labeling awareness score

Table 1: Patients' food labeling awareness level.

| Food labeling awareness | No | | Yes | |
|---|---|---|---|---|
| | Frequency (N) | Percentage (%) | Frequency (N) | Percentage (%) |
| 1. Do you always buy prepackaged food? * | 132 | 60.8% | 85 | 39.2% |
| 2. Do you always read Food Labels on prepackaged food? | 184 | 84.8% | 33 | 15.2% |
| 3. Do you look at the nutritional guidelines before making the purchase? | 147 | 67.7% | 70 | 32.3% |
| 4. Do you read the nutritional information presented on labels before you purchase a product? | 144 | 66.4% | 73 | 33.6% |
| 5. Do you understand the information displayed on nutritional labels? | 119 | 54.8% | 98 | 45.2% |
| 6. Do you know what the nutrients on food labels mean? | 148 | 68.2% | 69 | 31.8% |
| 7. Do you know how to calculate your grams intake according to per serving indicated on a food label? | 212 | 97.7% | 5 | 2.3% |
| 8. Do your buying decisions influenced by nutritional information on products? | 131 | 60.4% | 86 | 39.6% |
| 9. Do you believe that Food labels affect nutritional awareness? | 113 | 52.1% | 104 | 47.9% |
| **Total scale score M±SD** | 2.48±1.52 | | | |
| **Total scale score MD** | 2 out of 8 | | | |

Note: * – Not included in the total scale score. M – Mean; SD – Standard deviation; MD – Median.

Table 2: Food labeling awareness differences based on patients' sociodemographic characteristics.

| Variables | Category | Mean | SD | Test value | P-value |
|---|---|---|---|---|---|
| **Practicing sports** [1] | Yes<br>No | 3.17<br>2.05 | 2.64<br>2.35 | 4211.5 | 0.002* |
| **Smoking status** [1] | Smoker<br>Non-smoker | 3.49<br>2.22 | 2.63<br>2.43 | 2739.0 | 0.002* |
| **Gender** [1] | Male<br>Female | 2.55<br>2.44 | 2.49<br>2.54 | 5086.5 | 0.631 |
| **Marital status** [1] | Married<br>Single | 2.49<br>2.41 | 2.54<br>2.30 | 2094.5 | 0.852 |
| **Follow certain diet** [1] | Yes<br>No | 2.81<br>2.16 | 2.58<br>2.41 | 5024.5 | 0.055 |
| **Monthly income** [2] | <100<br>100–400<br>>400 | 0.67<br>2.31<br>3.49 | 1.21<br>2.50<br>2.48 | 9.485 | 0.002* |
| **Age groups** [2] | 18–38<br>39–59<br>60–80 | 2.58<br>3.11<br>1.71 | 2.36<br>2.60<br>2.29 | 7.654 | 0.001* |
| **Education level** [2] | Illiterate<br>Primary<br>Secondary<br>Diploma<br>University | 0.53<br>1.71<br>3.04<br>4.17<br>4.62 | 1.46<br>2.14<br>2.46<br>2.52<br>2.01 | 24.360 | <0.001* |

Note: * – Significant P-value<0.05; ** – Test value of Mann-Whitney [1], Welch ANOVA [2].

than (illiterate p-value<0.001, primary (p-value<0.001) and secondary (p-value=0.039) while did not significantly different from college holder (p-value=0.966). Likewise, those having college-level significantly had a higher mean food labeling awareness score than (illiterate p-value<0.001, primary p-value=0.002) but did not significantly different from secondary level (p-value=0.352). In the same context, those having a secondary educational level significantly had a higher Mean food labeling awareness score than those (illiterate p-value<0.001, primary p-value=0.008). Finally, the result has shown that the primary educational level has a higher labeling awareness score than the illiterate p-value=0.011.

Results in Table 3 revealed that the patient's BMI and WC in females were negatively correlated with food awareness level but they were not significant. Furthermore, WC in male was not significantly correlated with food label awareness. The result in Table 4 revealed that the food labeling awareness score has negatively shown a significant correlated with HbA1c and FBS (rho=-0.171, p-value=0.012, rho=-0.016, p-value=0.020 respectively) which indicates when food labeling awareness increases the level of HbA1c and FBS will decrease as well.

## Discussion

The present study results revealed that patients practicing sports significantly have a higher mean=3.17 food labeling awareness level than those who did not practicing sports mean=2.05 which is statistically significant (p-value=0.002). Kollannoor-Samuel *et al.* [20] study findings revealed that diabetic patients who performed above-median physical activity levels were more likely to use and aware of the nutrition label for food selection. Evenly, Sajdakowska *et al.* [21] observed that the respondents who performed physical activity had a positive impact on the probability of reading food labels. On the other hand, the present study results indicated that smoker patients significantly have a higher mean=3.49 food labeling awareness level than non-smokers mean=2.22, which is statistically significant (p-value=0.002). Likewise, Lee *et al.* [22] study findings indicated that the proportions of nutrition label awareness of diabetic patients participating were higher for smokers compared to patients who don't smoke.

The present study results showed a higher mean food labeling awareness score and statistically significant for those who earn >400JD/month (p=0.002) compared with those with an income level of <100/JOD and


https://doi.org/10.46389/rjd-2024-1444

Table 3: Relationship between food label awareness and anthropometric measurements glucose of the study participants (n=417).

| Variables | Food label awareness | | P-value |
|---|---|---|---|
| | Correlation test | Correlation coefficient value | |
| **BMI** | Spearman rho | -0.017 | 0.808 |
| **Male's WC** | Point-biserial | 0.114 | 0.333 |
| **Females' WC** | Point-biserial | -0.012 | 0.889 |

100–400/JOD had a lower mean food labeling awareness score, therefore the higher the participants' income level had higher food labels awareness. Walker *et al.* [23] indicated that low-income individuals with diabetes include the need focus on understanding the concepts of nutrition labels to improve their disease. Also, Jáuregui *et al.* [24] study findings revealed that participants of low household monthly income had low food labeling awareness and had purchases with lower nutritional quality products. On the other side, age shows statistically significant results revealing that the age group (39–59 yrs) significantly had a higher mean food labeling awareness score than those in the age group (60–80 yrs) while no significant Mean difference was detected between the age group of (18–38 yrs) with (39–59 yrs) and (60–80 yrs). Almost similarly, Binobead *et al.* [25] study indicated that the age category (31–40) of participants was statistically significant with their nutrition knowledge, opinions, and practices regarding food labels. Likewise, findings study by Hassan and Dimassi [26], revealed that the age category above 55 of participants reported a lower level of understanding and use of the food labels contrasted to younger age groups. Moreover, the present study findings revealed that those holding University degrees significantly had a higher mean food labeling awareness score than illiterate, primary, and secondary while not significantly different than college holders. Thus, the higher the education level of the participating patients, the higher their awareness level of food labels. Likewise, Alshukri *et al.* [27] study findings revealed more than half of respondents recognized food labeling as useful information and their education level was a bachelor's or diploma degree. Furthermore, Aryee *et al.* [28] corroborated the present study results, in which their study findings showed a very high level of awareness of food labels in a majority highly educated population.

The results in the present study revealed that the patient's BMI and WC in females were negatively correlated with food awareness level but they were not statistically significant. However, study of Restrepo [29] indicated that the awareness of calorie labeling on food labels is linked with total calories purchased and contributed to a reduction in BMI and reduction of weight in obese persons. A longitudinal study by Di Onofrio *et al.* [30] has taken the same variables as the present study, in which detailed nutritional information about how to manage T2DM was given to diabetic patients involving learning a correct interpretation of food labels which means elevated awareness of food labels. They noticed after 9 months an elevated awareness of food labels was associated with improving of all anthropometric parameters (BMI, WC, and blood pressure) in the intervention group comparing to the control group.

The result of the present study revealed that the food labeling awareness score has significantly inversely correlated with HbA1c and FBS (p=0.012, rho=-0.016, p=0.020) respectively indicating when food labeling awareness increases the level of HbA1c and FBS will decrease as well. Likewise, Kollannoor-Samuel *et al.* [31] indicated the key role of food label use in the consumption of higher nutritional quality diets and HbA1c control among T2DM patients and announced simple nutritional education intervention for food label awareness has equipped study participants with the skills to efficaciously read food labels, choose healthier

Table 4: Relationship between food label awareness and blood glucose of the study participants (n=417).

| Variables | | HbA1c | FBS |
|---|---|---|---|
| **Food labeling awareness** | Rho | -0.171 | -0.160 |
| | P-value | 0.012* | 0.020* |

Note: * – Significant P-value<0.05; FBS – Fasting blood sugar; HbA1c – Glycated hemoglobin; rho – Spearman Rank Correlation.

food products, and obtain better glycemic control. Also, study of Jin *et al*. [32] pointed out that the participants who had awareness of using the food label had not high FBS of about 82.0%. Otherwise, Lee *et al*. [22] study findings in respect of the awareness of nutrition labels according to diabetes-related characteristics announced that nearly half of diabetic patients participating have higher awareness and use of nutrition labels and consequently have HbA1c ≥6.5 and FBS ≥126.

## Conclusion

The results indicated that T2DM patients' awareness of food labels was very low. The findings of the present study indicated that T2DM patients are highly recommended to improve and increase their awareness regarding food label to elevate their ability in selection of healthier food products and consequently improving their anthropometric and biochemical measurements.

## Conflict of interest

The authors declare no conflict of interest.

## Ethical approval

The approval for this study was obtained from the Mu'tah University Research Ethics Committee (approval ID: MOH/REC/2022/239). Moreover, ethical approvals were obtained from the Jordanian Ministry of Health to access patients' data for both diabetes clinics in Madaba and Al Bashir Hospital in Amman.

## Consent to participate

Written informed consent was obtained from all the participants.

## References


1. Donga, G., & Patel, N. (2018). A Review of Research Studies on Factors Affecting Consumers' use of Nutritional Labels. Nutrition & Food Science, 7(3), 1–8. https://doi.org/10.19080/NFSIJ.2018.07.555713
2. Davidović, D., Paunović, K., Zarić, D., Jovanović, A., Vasiljević, N., Stošović, D., & Tomanić, M. (2021). Nutrition and health claims spectra of pre-packaged foods on Serbian supermarket shelves: A repeated cross-sectional study. Nutrients, 13(8), 1–13. https://doi.org/10.3390/nu13082832
3. de Boer, A. (2021). Fifteen years of regulating nutrition and health claims in europe: The past, the present and the future. Nutrients, 13(5), 1–19. https://doi.org/10.3390/nu13051725
4. Al-Awwad, N., Al-Sayyed, H., Safi, H., Al-Bosta, S., & Al-Zawawi, S. (2021). Highlights on the Labels of Packaged Foods Sold in Jordanian Market from A Cross-sectional Study. Current Research in Nutrition and Food Science, 9(3), 770–782. https://doi.org/10.12944/CRNFSJ.9.3.05
5. Viola, G., Bianchi, F., Croce, E., & Ceretti, E. (2016). Are food labels effective as a means of health prevention? Journal of Public Health Research, 5(3), 139–142. https://doi.org/10.4081/jphr.2016.768
6. Ojo, O. (2019). Nutrition and chronic conditions. Nutrients, 11(2), 9–14. https://doi.org/10.3390/nu11020459
7. Lewis, J., Arheart, K., LeBlanc, W., Fleming, L., Lee, D., Davila, E., Cabán-Martinez, A., Dietz, N., McCollister, K., Bandiera, F., & Clark, J. (2009). Food label use and awareness of nutritional information and recommendations among persons with chronic disease. American Journal of Clinical Nutrition, 90(5), 1351–1357. https://doi.org/10.3945/ajcn.2009.27684
8. Mohamed, M., Hussein, Z., Nazeri, A., & Chan, S. P. (2016). DiabCare 2013 : A cross-sectional study of hospital based diabetes care delivery and prevention of diabetes related complications in Malaysia. Med J Malaysia, 71(4), 177–185. http://www.e-mjm.org/2016/v71n4/diabetes-care.pdf
9. Pillon, N., Loos, R., Marshall, S., & Zierath, J. (2021). Metabolic consequences of obesity and type 2 diabetes: Balancing genes and environment for personalized care. Cell, 184(6), 1530–1544. https://doi.org/10.1016/j.cell.2021.02.012
10. WHO. (2021). Diabetes. World Health Organisation. https://www.who.int/news-room/fact-sheets/detail/diabetes
11. Dilworth, L., Facey, A., & Omoruyi, F. (2021). Diabetes mellitus and its metabolic complications: The role of adipose tissues. International Journal of Molecular Sciences, 22(14), 1–18. https://doi.org/10.3390/ijms22147644
12. Taylor, R., Ramachandran, A., Yancy, W., & Forouhi, N. (2021). Nutritional basis of type 2 diabetes remission. The BMJ, 374(9), 1–6. https://doi.org/10.1136/bmj.n1449
13. Ajlouni, K., Batieha, A., Jaddou, H., Khader, Y., Abdo, N., El-Khateeb, M., Hyassat, D., & Al-Louzi, D. (2019). Time trends in diabetes mellitus in Jordan between 1994 and 2017. Diabetic Medicine, 36(9), 1176–1197. https://doi.org/10.1111/dme.13894
14. Adesina, E., Ajayi, B., Amoo, E., Adeyeye, B., Ajayi, M., Olawande, T., Olawole-Isaac, A., & Udume, M. (2022). Consumers' Knowledge and Use of Nutritional Labelling Information in Lagos, Nigeria. Sustainability (Switzerland), 14(1), 1–16. https://doi.org/10.3390/su14010578
15. Wahab, R. (2018). Food Label Use and Awareness of Nutritional Information Among Consumers in Bahrain: An Exploratory Study. KnE Life Sciences, 4(6), 26. https://doi.org/10.18502/kls.v4i6.3088
16. WHO. (2017). World Health Organisation|Physical Measurements Overview Physical Measurements. World Health Organisation, January, 1–16. https://cdn.who.int/media/docs/default-source/ncds/ncd-surveillance/steps/part3-section5.pdf?sfvrsn=a46653c7_2
17. WHO. (1995). Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. In World


 https://doi.org/10.46389/rjd-2024-1444 

Health Organization technical report series (854). https://apps.who.int/iris/bitstream/handle/10665/37003/WHO_TRS_854.pdf?sequence=1&isAllowed=y

18. WHO. (2008). World Health Organisation| Waist Circumference and Waist–Hip Ratio. Report of a WHO Expert Consultation. World Health Organisation, December, 8–11. http://www.who.int
19. Klaib, A., & Nuser, M. (2019). Evaluating EHR and health care in Jordan according to the international health metrics network (HMN) framework and standards: A case study of hakeem. IEEE Access, 7(4), 51457–51465. https://doi.org/10.1109/ACCESS.2019.2911684
20. Kollannoor-Samuel, G., Shebl, F., Hawley, N., & Pérez-Escamilla, R. (2017). Nutrition label use is associated with lower longer-term diabetes risk in US adults. American Journal of Clinical Nutrition, 105(5), 1079–1085. https://doi.org/10.3945/ajcn.116.145359
21. Sajdakowska, M., Gębski, J., Wardaszka, A., & Wieczorek, A. (2022). Evaluation of Food Labelling the Products with Information Regarding the Level of Sugar: A Preliminary Study. Nutrients, 14(13), 1–14. https://doi.org/10.3390/nu14132697
22. Lee, S., Han, M., Park, J., & Ryu, S. (2022). Utilization of nutrition labels and related factors among patients with diabetes in Korea. Nutrition Research and Practice, 16(65), 1–10. https://doi.org/https://doi.org/10.4162/nrp.2022.16.e65
23. Walker, R., Grusnick, J., Garacci, E., Mendez, C., & Egede, L. (2019). Trends in Food Insecurity in the USA for Individuals with Prediabetes, Undiagnosed Diabetes, and Diagnosed Diabetes. Journal of General Internal Medicine, 34(1), 33–35. https://doi.org/10.1007/s11606-018-4651-z
24. Jáuregui, A., Vargas-Meza, J., Nieto, C., Contreras-Manzano, A., Alejandro, N., Tolentino-Mayo, L., Hall, M., & Barquera, S. (2020). Impact of front-of-pack nutrition labels on consumer purchasing intentions: A randomized experiment in low- And middle-income Mexican adults. BMC Public Health, 20(1), 1–13. https://doi.org/10.1186/s12889-020-08549-0
25. Binobead, M., Alotaibi, M., AlSedairy, S., Al-Harbi, L., Arzoo, S., & Al-Qahtani, W. (2022). Awareness and usage of nutrition information and effect of sociodemographic characteristics on various aspects of food labels in Al-Ahsa, Saudi Arabia. Nutrición Hospitalaria, 39(5), 1106–1116. https://doi.org/http://dx.doi.org/10.20960/nh.04087
26. Hassan, H., & Dimassi, H. (2017). Usage and Understanding of Food Labels among Lebanese Shoppers. International Journal of Consumer Studies, 41(5), 570–590. https://doi.org/https://doi.org/10.1111/ijcs.12368
27. Alshukri, A., Elramli, S., & Albkoush, H. (2020). Study of knowledge, attitude and awareness of the information of food labeling among consumers in Tripoli municipality Libya. IJRAR- International Journal of Research and Analytical Reviews, 7(2), 32–42. http://ijrar.com/upload_issue/ijrar_issue_20544169.pdf
28. Aryee, P., Helegbe, G., Agordoh, P., Mohammed, A., Muntala, J., SKoblaji, F., & Kumoji, H. (2019). Exploring consumer knowledge, understanding and use of food and nutrition label information in the tamale metropolis of Ghana. African Journal of Food, Agriculture, Nutrition and Development, 19(2), 14415–14431. https://doi.org/10.18697/AJFAND.85.17795
29. Restrepo, b. (2017). Calorie labeling in chain restaurants and body weight: evidence from New York. Health Economics, 1131(2007), 1–19. Https://doi.Org/10.1002/hec
30. Di Onofrio, V., Gallé, F., Di Dio, M., Belfiore, P., & Liguori, G. (2018). Effects of nutrition motivational intervention in patients affected by type 2 diabetes mellitus: A longitudinal study in Naples, South Italy. BMC Public Health, 18(1), 1–8. https://doi.org/10.1186/s12889-018-6101-6
31. Kollannoor-Samuel, G., Shebl, F., Segura-Pérez, S., Chhabra, J., Vega-López, S., & Pérez-Escamilla, R. (2016). Effects of food label use on diet quality and glycemic control among latinos with type 2 diabetes in a community health worker-supported intervention. American Journal of Public Health, 106(6), 1059–1066. https://doi.org/10.2105/AJPH.2016.303091
32. Jin, H., Choi, E., Kim, M., Oh, S., & Jang, S. (2019). Association between use of nutritional labeling and the metabolic syndrome and its components. International Journal of Environmental Research and Public Health, 16(22), 1016. https://doi.org/10.3390/ijerph16224486

 