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REVIEW ARTICLE

Metabolic syndrome among adults in Qatar: A review of the literature across medical specialties

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ABSTRACT

This study aims to collate all metabolic syndrome-related studies among adults in Qatar, shedding light on gaps in knowledge related to this topic to be addressed in future research studies. PubMed was used in searching for metabolic syndrome-related articles in Qatar, which was executed using relevant terms and was conducted with no restrictions.
A second search was executed at a later stage to include any recent publications. A total of 20 articles were found to be relevant and related to the topic in hand. Three definitions of metabolic syndrome were used across the reviewed studies, which were classified based on medical specialties. The main findings and key components of each study were summarized. Studies were unevenly distributed across various medical specialties. This article serves to direct future research activities by identifying what aspects of the disease have been covered under current or past research projects and what more needs to be addressed comprehensively in view of clinical and public health significance.

Keywords: metabolic syndrome, Qatar, public health, literature review, PubMed

INTRODUCTION

Obesity, hypertension, dyslipidemia, and insulin resistance are collectively known as metabolic syndrome.[1] Numerous studies have reported that an increased morbidity and mortality is associated with metabolic syndrome.[1–3] The number of metabolic syndrome cases continue to increase in developing countries,[4] to the point where some name it "the new epidemic."[5] A recent systematic review reported a high prevalence rate of metabolic syndrome in the Middle East.[6]

Qatar has witnessed substantial growth on many of its sectors, leading to an increase in gross domestic product.[7] Along with the growth came a rise of lifestyle-related diseases due to the adoption of an unhealthy lifestyle,[8] including the rise of metabolic syndrome figures among the population in Qatar.[8] A meta-analysis of cross-sectional studies in the Middle East reported that the prevalence of metabolic syndrome in Qatar ranges between 26% and 33%.[6] Al-Thani et al., in accordance to the results of a national health survey, reported that 28% of the Qatari population fulfills the criteria for metabolic syndrome based on the International Diabetes Federation (IDF) criteria.[9,10] An earlier study by Musallam et al. in 2008 had reported prevalence rates of 26.4% and 34 % in the Adult Treatment Panel III (ATP III) criteria[11] and the IDF criteria, respectively.[12] This paper aims to collate all published studies on metabolic syndrome among adults in Qatar, providing information on past research projects to identify areas for future research studies.

Search details

PubMed was used in searching for metabolic syndrome-related articles in Qatar. The search was conducted on April 23, 2019, and repeated on November 15, 2019, without restrictions of any type. The following term was used during the search: "metabolic syndrome AND Qatar." This review excluded articles on the following: a pediatric population, dissertations or thesis, pooled analysis, or reviews of any type. Data from each study was extracted into a table designed for the purpose of this article.

Reviewed studies

Considering the size and magnitude of the disease, we found insufficient research involving metabolic syndrome among adults in Qatar. The first search conducted in April returned 54 articles. The second search in November returned an additional 10. A total of 20 articles were identified as relevant and retrieved. Majority of the articles were cross-sectional (75%), cohort (15%), case control (5%), and experiments (5%). Studies were unevenly distributed across various medical specialties, mental health, public health, andrology, cardiology, nutrition, and others. For easy access for future researchers, the studies were presented per specialty. Table 1 summarizes all 20 studies that were included in this article.

Epidemiology

Qatar's general population shows that prevalence appears to cluster around 26% and 34% using ATP III and IDF criteria, respectively.[12,13] In 2010, Bener et al. reported on the gender- and age-related differences among metabolic syndrome patients. The study found that the prevalence of metabolic syndrome was highest among the age group of 30 – 39 years and 40 – 49 years among males and females, respectively.[14] In 2012, Ismail screened 136 patients in primary health care centers, reporting a metabolic syndrome prevalence rate of 46.3% among obese patients. The most commonly encountered factors were increased blood pressure and waist circumference, while being diabetic and increasing age were significantly found to increase the risk of metabolic syndrome. The findings of this study cannot be generalized to the remaining population due to its small sample size and all patients being in the primary health care center.[15] In 2016, Al-Thani et al. reported a 28% prevalence rate for metabolic syndrome among 2496 Qatari citizens, identifying waist circumference ($\geq$102 cm and $\geq$94 cm for men and women, respectively) as the best predictor for the presence of other metabolic syndrome-related factors.[9]

Public health

In 2013, Bener et al. attempted to identify the optimum cutoff values for various possible potential predictors of metabolic syndrome in Qatar, finding that waist circumferences of 99.5 cm and 91 cm for men and women, respectively, are better predictors of metabolic syndrome in Qatar.[16] Later in 2014, they highlighted the role of family history of metabolic syndrome in type 2 diabetes mellitus in Qatar, reporting a significantly ($P = 0.009$) higher proportion of metabolic syndrome patients with a positive family history of type 2 diabetes mellitus (46.7%) than without type 2 diabetes mellitus (33.8%).[17]

In relation to lifestyle patterns and metabolic syndrome, Al-Thani et al. recruited a sample of Qatari women and found that a high-risk lifestyle pattern and metabolic syndrome are associated.[18] Another related study found an inverse relationship between adhering to the Qatar dietary guidelines and metabolic syndrome in a sample of 1109 people in the Qatari population, further reporting that 83% of the sample did not meet the recommendations for dietary intake, including vegetables, fruits, legumes, high fiber, and

whole grains; 70% was classified as obese or overweight; 50% – 72% were reported to frequently consume sweetened beverages/sweets; and 47% consumed fast food frequently.[19] Under lifestyle management, Hammoudeh et al. conducted a clinical trial investigating the role of nonexercise activity thermogenesis (NEAT) on metabolic syndrome. A total of 200 participants were tested to find out whether increasing one's energy expenditure affects the components of metabolic syndrome. The study found no difference between the groups that followed NEAT and those who did not.[20]

Mental health

One study reported a higher prevalence of metabolic syndrome among schizophrenia patients than the general population (36.5% vs. 18.7%, $P < 0.001$). Schizophrenia patients were found to have twice the risk of developing metabolic syndrome in the sample. Central obesity was the most commonly encountered factor when compared to the general population.[21] In addition to obesity, high blood pressure was found to be among the factors that contribute the most to the increased prevalence in a sample of patients with mental disorders, although no difference in the prevalence of metabolic syndrome was reported when compared to the general population.[22] Another study investigated the sleeping patterns of mentally ill patients, regardless of their treatment, and found that they have extended sleep hours compared to healthy controls, which was further intensified by the use of antipsychotics. The study also found that being a female with central obesity was significantly associated with longer sleep duration.[23]

Heart disease

Al-Aqeedi et al., reported on the prevalence (69.4%) of metabolic syndrome among male patients with acute coronary syndrome (ACS) and without a history of diabetes. They found that common components among this population are decreased HDL (94.1%), increased fasting blood glucose (89.8%), increased triglycerides (81.8%), and increased waist circumference (61.7%).[24]

Nutrition

In relation to vitamin D, Al-Dabhani et al., studied the prevalence of vitamin D deficiency and its relationship with metabolic syndrome. They found that approximately 64% of the 1205 participants in this study were vitamin D-deficient, with a slightly increased number of vitamin D-deficient men (69%) than women (61%). Those with metabolic syndrome had 8% lower serum vitamin D than those without ($P = 0.01$). A significantly positive association was found for vitamin D deficiency with waist circumference, HDL, and high triglyceride levels.[25] Ganji et al., continued this line of work, demonstrating an inverse relationship between the prevalence of metabolic syndrome and the concentrations of serum 25-hydroxyvitmain D (25(OH)D) among Qatari women aged 20 to 80 years old, with obesity being the primary driver for metabolic syndrome and low levels of vitamin D.[26]

Another group of researchers investigated the relationship between vitamin D and metabolic syndrome in relation to hearing loss among diabetes patients. The study reported a significant association between vitamin D deficiency and metabolic syndrome on the one hand and hearing loss on the other hand in diabetes patients, as approximately 25% of the study sample reported hearing loss.[27]

Urology and andrology

Canguven et al. investigated the relationship between vitamin D treatment and metabolic syndrome, sexual hormones, and erectile dysfunction and found that treating vitamin D-deficient middle-aged men with egocalciferol (vitamin D2) significantly improved testosterone levels and erectile function ($P < 0.001$). The mean body mass index (BMI) was significantly decreased ($P = 0.001$), along with hemoglobin A1c (HbA1c) ($P = 0.001$), LDL ($P = 0.001$), and triglycerides ($P = 0.035$). No changes in luteinizing hormone (LH) levels were noted, whereas the prostate-specific antigen (PSA) values were significantly increased ($P < 0.001$).[28] Another study by Canguven et al., investigated the relationship between metabolic syndrome and testosterone therapy, showing that testosterone treatment improved components of metabolic syndrome and diabetes control with no adverse effects. Testosterone treatment was associated with a significant decrease in BMI ($P < 0.0001$) and total cholesterol ($P < 0.0001$) and triglyceride ($P = 0.016$) levels and an increase in HbA1c ($P < 0.0001$) level.[29]

Obstetrics

Al-Hail et al., studied creatine kinase (CK) and metabolic syndrome features among women with and without polycystic ovarian syndrome and found that

Table 1. A summary of reviewed articles.

#	Authors	Year	Aim	Sample size	Study design	Measurements	Limitations	Definition
1	Musallam et al.[12]	2008	To estimate the prevalence of metabolic syndrome and associated risk factors	817 Qataris (405 males, 412 females) Age: > 20 yrs.	Cross sectional	-Sociodemographic characteristics -Family history of diabetes and hypertension -Lifestyle habits -Anthropometric measurements, BMI -Blood pressure -Impaired glucose tolerance -Triglycerides, HDL	-Cross-sectional design	ATP III, IDF
2	Bener et al.[13]	2009	To examine the prevalence of metabolic syndrome and assess the component with the highest risk	1204 Qataris (594 males, 610 females) Age: > 20 yrs.	Cross sectional	-Sociodemographic characteristics -Family history of diabetes and hypertension -Lifestyle habits -Anthropometric measurements, BMI -Blood pressure -FBG -Triglycerides, HDL	-Cross-sectional design	ATP III, IDF
3	Bener et al.[14]	2010	To examine the gender- and age-related differences among metabolic syndrome patients	1222 Qataris (612 males, 610 females) Age: > 20 yrs.	Cross sectional	-Sociodemographic characteristics -Lifestyle habits -Family history of diabetes and hypertension -Anthropometric measurements, BMI -Blood pressure -Triglycerides, HDL -FBG	-The systematic sampling procedure may underestimate the prevalence -The age distribution may not be representative of the population	ATP III, IDF

Table 1 – *continued*

#	Authors	Year	Aim	Sample size	Study design	Measurements	Limitations	Definition
4	Ismail[15]	2012	To determine the prevalence of metabolic syndrome and identify associated factors	136 Qatari obese patients (66 males, 70 females) Age: >18 yrs.	Cross sectional	-Sociodemographic characteristics -Anthropometric measurements, BMI -Blood pressure -FBG -Triglyceride, HDL	-Relatively small sample size -All patients were in the primary health care center	IDF
5	Al-Thani et al.[9]	2016	To assess the prevalence of metabolic syndrome and to determine optimum measurements for abdominal obesity	2496 Qataris (1053 males, 1443 females) Age:18 – 64 yrs.	Cross sectional, national health survey	-Sociodemographic and behavioral risk factors -History of diabetes, hypertension, and oral health -Height, weight, waist circumference, hip circumference, BMI -Blood pressure -FBG -Lipid profile	-Self-reported dietary information (i.e., estimated) -Missing data on blood biomarkers (only 55% of participants provided a blood sample)	IDF
6	Bener et al.[16]	2013	To identify the cutoffs for local predictors of metabolic syndrome in Qatar and determine the best predictor	1552 (758 males, 794 females) Age: >20 yrs.	Cross sectional	-Sociodemographic characteristics -Anthropometric measurements, BMI -Lifestyle habits -Blood pressure -FBG, HbA1c -Lipid profile	-Study design did not allow causal inferences -Nonresponse bias	ATP III, IDF
7	Hammoudeh et al.[20]	2013	To examine the influence of introducing a lifestyle intervention based on non- exercise activity thermogenesis on reducing the burden of metabolic syndrome	Total: 200 patients with metabolic syndrome (120 males, 80 females) Study group (n = 100) Control group (n = 100) Age: >18 yrs.	Randomized experiment	-Sociodemographic characteristics -Anthropometric measurements, BMI -FBG -Lipid profile -Blood pressure -Information on medications; antidiabetic, antihypertensive, lipid-lowering medications	-High dropout rate and missing data -Self-reported information -Occurrence of the month of fasting (Ramadan)	IDF

Table 1 – *continued*

#	Authors	Year	Aim	Sample size	Study design	Measurements	Limitations	Definition
8	Bener et al.[17]	2014	To study the impact of family history with metabolic syndrome and consanguinity among these patients on developing type 2 diabetes mellitus	1552 Qatari (758 males, 794 females) Age: >20 yrs.	Cross sectional	-Socio-demographic characteristics -Anthropometric measurements, BMI -Family history of diabetes, hypertension, and metabolic syndrome -Lifestyle habits -Blood Pressure -Lipid profile -FBG	-The inability to draw causal inferences due to study design -Variations in family history	ATP III, IDF
9	Al-Thani et al.[18]	2016	To investigate the lifestyle patterns in relation to metabolic syndrome	418 not pregnant Qatari women Age: 18–45 yrs.	Cross sectional	-Sociodemographic characteristics -Lifestyle characteristics; dietary intake, meal pattern, physical activity -Anthropometric measurements, BMI -Blood pressure -FBG -Triglycerides, HDL	-Cross-sectional design -Survey instruments limitation (e.g., no information on portion size) - Interview approach limitation (e.g., social desirability bias) -Limitation related to the use of Principal Component Factor Analysis for lifestyle derivation patterns	ATP III
10	Al-Thani et al.[19]	2018	To examine the adherence to the Qatar dietary guidelines and metabolic syndrome	1109 Qataris (570 males, 539 females) Age:18–64 yrs.	Cross sectional	-Sociodemographic characteristics -Lifestyle characteristics -Family history of diabetes and hypertension -Dietary intake using Food Frequency Questionnaire (FFQ) -Anthropometric measurements, BMI -Blood pressure -FBG -Triglycerides, HDL	-Cross-sectional design -Dietary intake and physical activity assessment was self -reported (i.e., recall error) -Use of not validated assessment tools (e.g., FFQ) -Interview approach limitation (e.g., social desirability bias) -Questionnaire-based survey limitation	Joint Interim Statement [35]

Table 1 – *continued*

#	Authors	Year	Aim	Sample size	Study design	Measurements	Limitations	Definition
11	Bener et al.[21]	2014	To examine the prevalence of metabolic syndrome among patients with schizophrenia	Total: 699 (341 males, 358 females) Study group: subjects with schizophrenia (n = 233) Control group (n = 466) Age: > 20 yrs.	Matched case control	-Sociodemographic characteristics -Physical examination -Lifestyle habits -Anthropometric measurements, BMI -Blood pressure -FBG -Triglycerides, HDL	-Selection bias	ATP III
12	Hammoudeh et al.[22]	2018	To compare the prevalence of metabolic syndrome between a group of subjects taking antipsychotics for at least 6 months and a healthy control group and determine the factors contributing to the development of metabolic syndrome	Total: 226 (142 males, 84 females) Study group: patients receiving antipsychotics (n = 112) Control group: general population (n = 114) Age: 18 – 65 yrs.	Cross sectional	-Sociodemographic characteristics -Medical/psychiatric and family history -Type/duration of antipsychotic intake -Blood pressure, heart rate -Anthropometric measurements, BMI -Complete cell count (CBC) -Lipid profile -FBG, HbA1c -Liver and kidney functions	-Sample size -Majority of the people in the sample were male -Uneven representation of the nationalities -Large variations in antipsychotic doses and the duration of illness	ATP III, IDF

Table 1 – *continued*

#	Authors	Year	Aim	Sample size	Study design	Measurements	Limitations	Definition
13	Kiwan et al.[23]	2019	To compare sleep patterns among three groups: psychiatric patients maintained on antipsychotics, psychiatric patients not on antipsychotics, and healthy controls	Total: 339 (219 males, 120 females) -Patients on antipsychotics (n = 112) -Patients not taking AP for the last 6 months (n = 101) -Control group: healthy individuals (n = 126) Age: 18 – 65 yrs.	Cross sectional	-Sociodemographic characteristics -Medical and psychiatric history -Sleep patterns -Anthropometric measurements, BMI -Blood pressure, heart rate -Lipid profile -FBG, HbA1c -Mini international neuropsychiatric interview questionnaire	-Most subjects in the patient groups were Qataris, while subjects in the control group were not -Heterogeneity of the study samples -Design limits inferential conclusions about causal relationships -Sleep duration was self-reported	IDF
14	Al-Aqeedi et al.[24]	2013	To ascertain the prevalence of metabolic syndrome among male patients with ACS and without a history of diabetes	467 males with ACS Age: 49.7 ± 10.7 yrs.	Cross sectional, prospective	-Sociodemographic characteristics -Clinical characteristic (e.g., smoking, ACS type) -Anthropometric measurements, BMI -Blood pressure -Troponin-T, CK-MB -Triglycerides, HDL -FBG	-Cross-sectional design	Joint Interim Statement

Table 1 – *continued*

#	Authors	Year	Aim	Sample size	Study design	Measurements	Limitations	Definition
15	Al-Dabhani et al.[25]	2017	To study the prevalence of vitamin D deficiency and relationship with metabolic syndrome	1205 Qataris and long- term non-Qatari residents (702 females, 503 males) Age: 18 – 80 yrs.	Cross sectional	-Sociodemographic characteristics -Lifestyle habits -Anthropometric measurements and body composition -Blood pressure -Bone and joint markers - Coagulation biomarkers - Diabetes biomarkers -Differential white cell count, CBC -Sex steroid hormones -Lipid profile -Minerals, vitamins	-Relatively small sample size -Low response rate for some questions -Study design	IDF
16	Bener et al.[27]	2017	To examine the relationship between metabolic syndrome and vitamin D deficiency on hearing loss in a sample of type 2 diabetes mellitus patients	Total: 528 subjects with hearing difficulty (201 males, 258 females) Study group: metabolic syndrome and hearing loss (n = 140) Control group: without metabolic and normal hearing (n = 388) Age: 20 – 59 yrs.	Cohort study	-Sociodemographic characteristics -BMI -Comorbid symptoms, diabetic complications -Blood pressure -Vitamin D -Lipid profile -FBG, HbA1c -Hearing sensitivity	-Selection bias -Restricted age group	ATP III

Table 1 – *continued*

#	Authors	Year	Aim	Sample size	Study design	Measurements	Limitations	Definition
17	Ganji et al.[26]	2019	To examine the relationship between metabolic syndrome and the concentrations of serum 25(OH)D	700 women (citizens and long-term residents) Age: 20–80 yrs.	Cross sectional	-Sociodemographic characteristics -Lifestyle characteristics -Waist circumference, BMI -Blood pressure -FBG, HbA1c -Triglycerides, HDL - 25(OH)D	-Study design did not allow a cause and effect association -Wide age and BMI ranges - Small sample size in each vitamin D quartile	IDF
18	Canguven et al.[28]	2017	To evaluate the association of a monthly high dose of vitamin D with sexual hormones, metabolic syndrome, erectile function, and prostate markers	102 males with serum vitamin D deficiency (< 30 ng/ml) Age: ≥ 35 yrs.	Cohort, prospective	-Sociodemographic characteristics -Medical history -Physical examination -Weight, height, BMI -25(OH)D, TT, parathyroid hormone, estradiol, LH - HbA1c -Lipid profile - PSA -Erectile function; IIEF-5 score	-No blood pressure measurement -No assessment of seasonal fluctuation of TT and vitamin D -Design did not allow study of causation of erectile dysfunction -Self-reported information on erectile dysfunction -No data on diet, exercise, or erectogenic medications -No control group	-
19	Canguven et al.[29]	2017	To evaluate the association between testosterone treatment and hormonal, anthropometric, and biochemical features	88 males with medical history of erectile dysfunction Age: 51.1 ± 13.0 yrs.	Cohort, prospective	-Sociodemographic characteristics -Anthropometric Measurements, BMI -Testosterone, estradiol -Hemoglobin, hematocrit, -Lipid profile -Liver enzymes -HbA1c -PSA	- No data on ancillary hormones (e.g., free testosterone, sex hormone-binding globulin (SHBG) due to system limitation, did not allow assessment of bioavailable testosterone -The short follow-up period (up to 12 months), did not allow assessment of longer-term effects of Testosterone therapy -No control group	-

Table 1 – *continued*

#	Authors	Year	Aim	Sample size	Study design	Measurements	Limitations	Definition
20	Al-Hail et al.[30]	2019	To determine the correlation between CK and metabolic syndrome among women with and without polycystic ovarian syndrome	Total: 660 women Study group: polycystic ovarian syndrome (n = 97) Control group (n = 563) Age: 18–40 yrs.	Cross sectional	-Sociodemographic characteristics -Height, weight, waist circumference, BMI -Blood pressure -Lipid profile -FBG, HbA1c -CK -Thyroid-stimulating hormone, prolactin, testosterone, C-reactive protein (CRP), insulin, insulin resistance (HOMA-IR), dehydroepiandrosterone sulfate, and SHBG -White blood cell count	-Study design limited the available data and sample types (e.g., did not allow measurement of abdominal adipose tissue and inflammatory markers other than with CRP, did not allow access to muscle biopsy tissue)	IDF

CK, independent of the polycystic ovarian syndrome phenotype, is associated with an increase in BMI and waist circumference (>80 cm) and with two or more features of the metabolic syndrome.[30]

DISCUSSION

The article in hand gathered and summarized the literature involving metabolic syndrome in Qatar and was published on PubMed. The current literature on metabolic syndrome in Qatar seems to be clustered under a handful number of specialties or topics, wherein other areas seem to lack studies involving metabolic syndrome and therefore could create an opportunity for future possible research. The majority of articles were public health/epidemiology related, with a scattered number of articles falling under other medical specialties. More diverse and specialized research under other specialties is required, needed, and encouraged to ascertain the extent of the disease and other disease-related aspects and to aid in formulating possible potential and effective strategies in the prevention of such metabolic syndrome. Furthermore, regarding the discussion, this is basically taken from the highlights of each of the studies included in the review. Following the order is not usually a requirement, as we wanted to cover those matters from a population level first and then an individual level.

Metabolic syndrome is a pandemic that continues to burden societies,[31,32] including the Qatari society as illustrated in the increasing number of metabolic syndrome cases, the prevalence of which ranged from 26% to 34%,[12,13] with highest rates reported among those aged 30 to 39 years among males and 40 to 49 years among females.[14] Interventions targeting the various components of the syndrome are needed[4] with specific focus on these age groups. Lifestyle changes are among those that have been cited as beneficial.[33] In an international panel recommendation, physical activity and several lifestyle habits were highlighted as prevention methods.[34] In the reviewed articles, Al-Thani et al., have shown that the majority of Qatari adults do not meet the recommendations for certain dietary intake.[19] Together with Bener et al.,[18] they flagged the need to investigate the social and cultural factors influencing the dietary habits in Qatar and highlighted the need for culturally sensitive interventions at the population and individual levels.[18] Raising awareness comes at the front of these efforts and can be implemented

through campaigns targeting the negative consequences of the disease along with the possible preventive measures that can be taken.[12] Given the widespread prevalence of vitamin D deficiency in Qatar, recommendations for vitamin D supplementation and fortifying staple foods with vitamin D were given.[25] Screening for type 2 diabetes mellitus among metabolic syndrome patients[17] and the use of testosterone therapy to reverse metabolic syndrome and improve glycemic control in hypogonadal men[28] were among the recommended interventions in the reviewed articles.

CONCLUSION

This article serves as a road map for future research work involving metabolic syndrome in Qatar by providing an overview of what has been done under each medical specialty, if any. Building on the identified gaps, this review highlights the need for a more detailed and comprehensive approach in future research (including both observational and experimental research studies at a larger population scale) involving metabolic syndrome and its related aspects.

Abbreviations

ACS, acute coronary syndrome; AP, antipsychotic; ATP III, Adult Treatment Panel III; BMI, body mass index; CBC, complete blood count; CK, creatine kinase; CRP, C-reactive protein; FBG, fasting blood glucose; FFQ, Food Frequency Questionnaire; HbA1c, hemoglobin A1c; HDL, high-density lipoprotein; IDF, International Diabetes Federation; LH, luteinizing hormone; NEAT, nonexercise activity thermogenesis; PSA, prostate-specific antigen; SHBG, sex hormone-binding globulin, TT, total testosterone; 25(OH)D, 25-hydroxyvitamin D

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