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ORIGINAL ARTICLE

Knowledge Gaps and Perceptions of Future Research Directions on Management of Diabetes during Ramadan Fasting: An Online Survey of Physicians

Short Title: *Gaps and directions in Ramadan-diabetes research*

Salem A Beshyah¹, Khawla F Ali², Issam M Hajjaji^{3,4}, Khadija Hafidh^{1,5}, Syed Abbas Raza⁶, Nazim Ghour^{7,8}, Ines Khochtali⁹

¹Department of Medicine, Dubai Medical College, Dubai, United Arab Emirates.

E-mail: Beshyah@yahoo.com

²Department of Medicine, Royal College of Surgeons in Ireland Medical University of Bahrain, Adliya, Bahrain. E-mail: kali@rcsi-mub.com

³Department of Medicine, Faculty of Medicine, University of Tripoli, Tripoli, Libya.

⁴National Centre for Diabetes, Tripoli, Libya. E-mail: issam@dr.com

⁵Department of Diabetes and Endocrinology, Rashid Hospital, DHA, Dubai, United Arab Emirates.

⁶Department of Endocrinology, Shaukat Khanum Hospital, and Research Center, Lahore, Pakistan. E-mail: sabbasraza@hotmail.com

⁷Queen Elizabeth University Hospital, Glasgow, Scotland, United Kingdom; Institute of Cardiovascular and Medical Sciences, BHF Glasgow Cardiovascular Research Centre,

⁸University of Glasgow, Glasgow, Scotland, United Kingdom. E-mail: nazim.ghouri@glasgow.ac.uk

⁹Endocrinology and Internal Medicine Department, Fattouma Bourguiba University Hospital, Monastir, Tunisia. E-mail: ineskhoc@yahoo.fr

Corresponding author:

Dr. Salem A Beshyah
Department of Medicine,
Dubai Medical College,
Dubai,
The United Arab Emirates.

Electronic address: beshyah@yahoo.com

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ABSTRACT

Objectives

Current knowledge and research on diabetes and Ramadan form the basis for evidence-based clinical practice. In this context, we aimed to explore physicians' perceptions of current knowledge gaps about research fasting (RF), barriers to, and foreseeable directions for advancement of the field.

Methods

We conducted an online survey of a convenience sample of 260 physicians from 27 countries. The survey questionnaire addressed three main domains: perceived current knowledge gaps and unmet needs in research about RF and diabetes, barriers to the conduct of research, and future directions for furthering the evidence in this field.

Results

Majority of respondents (65.7%) were senior physicians in adult endocrinology/diabetes (45.9%) working at tertiary centers (65.2%). The majority (67.3%) reported seeing an average of 20+ patients with diabetes weekly and felt "very or fairly confident" in managing diabetes during RF (67.7%). The knowledge gaps identified were the management of high-risk patients with diabetes (54.1%), such as renal impairment (59.8%), and pregnancy (61.5%). The main barriers to research were lack of adequate funding to academic centers (75.7%) and lack of interest of institutions in the subject (64.6%). Future efforts should be directed at the conduct of large epidemiological studies (49.5%) or double-blinded, placebo-controlled clinical trials (48.6%) to address the former gaps. Research findings should be widely disseminated via hands-on workshops (recommended by 70.3% of respondents) or international conferences (61.2%).

Conclusions: There is a wide agreement regarding the knowledge gaps in the management of diabetes during RF. Future efforts should focus on addressing these critical deficiencies.\

Keywords: Ramadan fasting, Literature, Diabetes, Hypoglycaemia, Epidemiology, Diabetic ketoacidosis, Patients' perspectives, Health Care Professionals perceptions. High-risk patients. Children and adolescents

1. INTRODUCTION

During Ramadan, the 9th lunar Islamic month, fasting entails adult Muslims' abstinence from food, water, all oral substances that include intravenous fluid therapy, from dawn to sunset.^[1] The impact of Ramadan fasting (RF) on health and disease stems from the biological impact of prolonged fasting on physiological and pathological parameters of disease states.^[2] RF has also been associated with drastic societal changes in lifestyle and eating habits during Ramadan, often manifested as increases in consumption of carbohydrate- and fat-rich foods, along with alterations in the sleep-wake cycles^[1] The former aggregation of abrupt physiological and lifestyle changes, prompted by RF, creates significant challenges in patients' medical care during the holy month. Additionally, with the increasing level of complexity of chronic diseases and therapeutics, healthcare providers cannot rely solely on personal anecdotes, impressions, or even consensus to manage disease during Ramadan.^[3, 4] Instead, providers

are calling for a strong body of evidence informing the development of disease-specific guidelines during the month of Ramadan.^[5]

Diabetes mellitus, with its increasing global prevalence, has been the most extensively investigated chronic disease state concerning RF.^[6] It has been demonstrated in a large epidemiological study that 42.8% of patients with type 1 diabetes and 78.8% of those with type 2 diabetes fast during Ramadan.^[7] Ramadan presents both patients and health providers with significant and complex challenges relating to fasting, such as hypoglycemia, hyperglycemia, ketoacidosis, and dehydration. In the last decade there has been several management recommendations by different groups^[8-14] Despite the increasing volume of RF literature in previous years, significant concerns exist regarding the quality of evidence and its robustness in altering or improving practices.^[3-5]

Current knowledge and research on diabetes and RF form the basis for evidence-based clinical practice. In this context and to further navigate the case of research on RF, we aimed to explore physicians' perceptions of current knowledge gaps relating to diabetes and RF. Also, we aimed to explore perceived barriers to researching diabetes and RF and any foreseeable directions for future advancement. We aim to provide baseline data to inform best implementation practices of evidence and guidelines to optimize the management of diabetes during Ramadan.

2. MATERIALS AND METHODS

2.1. Study design

We conducted a cross-sectional electronic questionnaire-based study between 19th September and 28th October 2020. For the creation, dissemination, and analysis of the questionnaire, Survey Monkey® (SVMK Inc., San Mateo, California, USA) was used. The questionnaire was electronically sent to a convenience sample of physicians on the authors' database and personal medical contacts on the authors' social media. The databases have medical contacts accumulated from previous studies with a preponderance of the Middle East and Africa respondents. The primary targeted regions included the Middle East, North Africa, South East Asia and Europe, however responses from other regions were retained. An initial invitation email explained the study. Reminders were sent twice-weekly to both the non-responders and partial responders. The survey service automatically blocked repeat submissions from the same internet protocol address. The included in analysed responses only included physicians and excluded all other healthcare professionals such as nursing, dentistry, and pharmacy.

2.2 Survey questions

The questions were developed *de novo* to cover the objectives of the study. The contents of the survey was based on review of the literature and the authors' own familiarity with the current research, guidelines, and clinical practice.^[15-17] The questionnaire was in the form of closed-ended multiple-choice questions, including a single response, multiple responses, and grids. The survey was served only once and no interrogation of respondents was undertaken. The questionnaire was served in English and French being the two languages used in professional life in majority of the target regions. The survey questions and potential responses are provided fully in **Appendix 1 in the online Supplementary Material**. Briefly, the survey included questions in 4 domains; the clinical load and extent of involvement in Ramadan activities, physicians' perceptions of the current Ramadan Research status, gaps in knowledge and research, and barriers to it, and areas for future research and optimal ways of dissemination of research and guidance. Since the questions were sent to a large pool of potential participants, additional questions were used to characterize the respondents' demographic and professional profiles, as described in our previous studies of similar nature.^[18-19]

2.3 Data management and statistical analysis

Survey responses were anonymously collected and stored electronically by the survey service, accessible in a password-protected manner. No data were captured on those who did not respond, declined to participate, or provided remarkably incomplete responses. The survey results were analysed using quantitative methodology due to the nature of the data. Sampling was based on convenience sampling and therefore we have not calculated specific sample size. The survey management service tools were used for the initial examination of results and descriptive analysis. Summary statistics were prepared for responses to each question. Since not every participant answered all questions, the percentage adjustment was used for respondents providing a given answer was calculated individually for each question, using the number of respondents to that question as the denominator. Data are presented for the whole group of respondents and were not stratified by region as the respondents were expressing their individual opinion rather than regional issues or concerns.

3. RESULTS

3.1 Profiles of respondents

Only data of full and meaningful responses were included. Due to the nature of the pool, responses rate could not be calculated. A total of 260 responses were included in the analysis. There were more respondents from the Middle East (129; 49.6%) and Africa (76; 29.2%), compared to South East Asia (30; 11.5%) and the rest of the world (25; 9.6%). Responses originated from 27 countries (Table 1). There were slightly more men (54%) than women (46%) among the 248 who declared their sex. Those between 41-50 years of age represented 30%, and those between 31-40 years and 51-60 years comprised 22.8% each. Senior physicians accounted for two-thirds of the respondents (65.7%). The leading two specialties accounting for almost two thirds (64.3%) of respondents were adult endocrinology (45.9%) and general medicine (18.4%). Many respondents practiced in academic tertiary referral centers (65.2%) and state-owned facilities (71.5%). The remainder of respondent characteristics is found in **Table 1**.

3.2 Involvement in diabetes care during Ramadan

The clinical burden in diabetes care and engagement in managing people with diabetes during Ramadan is summarized in **Table 1 and Figure 1**. Seventy-one respondents (29.7%) reported seeing 21-40 patients with diabetes weekly, and 91 respondents (38.3%) stated that more than three-quarters of their patients were likely to observe Ramadan fasting. Over a quarter of respondents (72; 27.7%) reported attending no diabetes education workshops dedicated to diabetes and Ramadan in the previous two years, while 96 (36.9%), 56 (21.5%), and 36 (13.9%) reported attending 1-2, 3-4, and ≥5 sessions, respectively (**Figure 1a**). When assessed on the level of confidence in managing diabetes during Ramadan, 38.5% and 29.2% stated they were "very confident" and "fairly confident," respectively. (**Figure 1b**). Of the 258 respondents who reported their preferred guidelines for RF, 46.5% reported using the International Diabetes Federation (IDF), in collaboration with the Diabetes and Ramadan (DAR) International Alliance guidelines, while 32.2% reported using the American Diabetes Association (ADA) guidelines. Smaller proportions used the British guidelines (13.2%), the South Asian Health Foundation (UK) guidelines (6.6%), the International Society for Paediatric and Adolescent Diabetes (ISPAD) guidelines (6.2%), Diabetes Canada (5.8%), South Asian consensus statement on women's health and Ramadan (4.7%) or other guidelines not mentioned above (5.0%). Additionally, a substantial number indicated that they depended on what they have learned themselves (17.8%) or what they have picked from educational activities (15.5%).

3.3 Respondents' perception of the current status of Ramadan research

The respondents' view of the statement "Relatively, I think there has been adequate research and publication on managing diabetes during Ramadan fasting" is shown in **Figure 2**. Also, **Table 3** presents the areas identified by respondents as recognized gaps in knowledge about the management of diabetes during Ramadan fasting. Out of 244 respondents, the most commonly identified gaps involved fasting with diabetes and pregnancy, the safety of fasting in people with impaired renal function & post-transplant, and practical management of high-risk groups. Majority-positive responses were evident for recognition of the limited data on high-risk patients, the need for better definition of high/very risk patient grouping, more guidance on optimal use of high technology, and the safety of fasting in old children and adolescents with diabetes, among other clinical issues (**Table 2**).

Also, there was considerable concordance amongst respondents' extent of agreement on few selected statements regarding the gaps in knowledge on Ramadan fasting and diabetes research, such as inadequate funding of academic centers in Muslim-majority countries to undertake good quality and unbiased research. These also included the lack of adequate interest from academic centers in Muslim-majority countries, that the pharmaceutical industry is overtaking current research, and efforts are divided between research groups with more competition than collaborations. More than half think that "Ramadan researchers" are motivated by an academic interest in the subject

3.4 Future research directions and publications

Respondents were asked to rank several future research questions (**Table 3**). Questions such as whether newer pharmacological agents are better than older ones if used correctly and how to best organize health care before, during, and after Ramadan were ranked very highly. These were followed by the value of using social media to support people with diabetes fast during Ramadan, and the impact of fasting on medical complications of diabetes, and how to avoid or reduce this. However, further surveys on the knowledge, attitudes, and practices of either healthcare professionals or people with diabetes on Ramadan fasting were not ranked highly (**Table 3**). The last three questions focused on identifying the respondents' views on the most appropriate research studies, article types, and venues for communication of research results and recommendations on management (**Table 3**). large epidemiological studies, double-blinded, placebo-controlled trials, cross-sectional observational studies, and long-term studies were the top 4 research methods favored by respondents. Original research reports, systematic reviews & meta-analysis, consensus statements, and summaries of workshops were considered as the top 4 most popular types of articles to address the subject. Venues of communication and dissemination of information were delivered best by workshops with hands-on case discussions, interactive cases followed by international and national and regional conferences. However, a notable proportion suggested embedding Ramadan sessions into other professional/academic events (**Table 3**).

4. DISCUSSION

Management of diabetes during Ramadan continues to be challenging for both patients and healthcare providers. Although there has been considerable interest in the topic over the last decade, many healthcare providers acknowledge that significant knowledge gaps still exist.^[20] Large bibliometric studies demonstrated a relentless rise in the number of publications over the last three decades.^[6] However, numerically, they were remarkably lower than expected for such a "phenomenon" that involves millions of Muslims all over the world.

Current consensus guidelines on diabetes management during Ramadan are based, to a large extent, on observational studies and a few randomized clinical trials with small numbers of patients. Although Sherif and Lakhadar a decade ago welcomed consensus on the management of common clinical conditions, they stressed even then that more evidence-based practice guidance is vital.^[3] Also, following a review of both randomized and observational studies, Alsifri et al, pointed out that there were significant discrepancies and a lack of heterogeneity in the published literature.^[4] The studies they reviewed were not comparable in terms of their design, patient eligibility, exclusion criteria, and definitions of outcomes assessed. Furthermore, they highlighted that most studies focused on safety rather than efficacy endpoints, and thus high-risk populations were usually excluded. Therefore, there is a need to systematically and broadly assess academics and clinicians' views on current significant gaps in knowledge, unmet needs of care, and the most relevant directions for research objectives and methodology in the field of RF.

The present study utilized an online survey for purposes of global and rapid assessment of the research objectives. Online surveys do not only offer time- and effort-saving benefits; they also allow widely-distributed populations of respondents to express their genuine opinion under little to no pressure. This approach has proven successful in our region in producing meaningful data.^[18,19] We are cognizant of the notion that the sample size may have been smaller than expected but despite our best attempts. Repeated reminders through the study duration to encourage participants to provide responses till the return was clearly diminishing to almost no response on the last reminder. However, many survey-based studies from our and other groups were of similar size, yet they were considered valid.^[18,19] Notwithstanding, we are not complacent about this as larger sample sizes do produce better quality data and are encouraged in future studies.

Many of the respondents identified the guidelines used by them, two of which were in the lead.^[11,12] However, it is highlighted in the current survey that the majority of the respondents agree that knowledge gaps related to RF do exist in areas that involve high-risk groups, similar to what is observed outside of Ramadan management. These are the usual areas that are also challenging outside Ramadan.^[21-26] These include fasting for individuals with diabetes and concomitant pregnancy, those with impaired renal function or post-transplantation, adolescents, and young adults with type 1 diabetes echo previously raised concerns in the literature.^[21-26] Optimal use of technology during Ramadan is another evolving facet. Technology has emerged as an important tool for addressing glycaemic control.^[27] However, given the costs and lack of expertise among many healthcare providers, this has not been widely available to patients with diabetes.

Additionally, most of the current published literature on RF stems from studies conducted in the Middle East region, where cultural norms significantly differ within different parts of the same region and from the rest of the world. Cultural differences, coupled with the lack of heterogeneity in studies, might affect physicians' confidence in providing good advice to their patients. A mere 39% were "very confident"

in managing their patients during Ramadan, even though most of the respondents were reportedly senior practicing clinicians. [20]

Another aspect that might reduce confidence would be related to very few, namely attending dedicated Ramadan educational workshops. The latter point was emphasized by Ahmedani et al. when reporting on the knowledge, attitudes, and practices of general practitioners related to diabetes management during Ramadan in Pakistan.[28] They reported that almost one-third of the general practitioners surveyed across Pakistan, a Muslim-majority country where many patients with diabetes opt to fast, lacked basic principles in the management of diabetes during Ramadan. This prompts a need to promote educational programs focused on the management of diabetes during Ramadan.[29] Our survey Respondents also agreed on this strategy, favouring disseminating information via workshops with interactive case discussions followed by international and regional conferences. While various international diabetes societies have made concerted efforts in putting together guidelines for assisting physicians, hands-on workshops seem equally crucial to clinicians to put those guidelines into practice.

Additionally, respondents agreed that there was inadequate funding from academic institutions in Muslim-majority countries to generate good quality and unbiased Ramadan-based research. Furthermore, with the lack of unified academic institutions coupled with limited funding, researchers are motivated mainly based on their academic interests.[30,31] The remainder of this void, frequently being filled by industrial parties and pharma companies.

The majority of respondents agreed that there is a need for extensive epidemiological studies, double-blinded randomized controlled trials, and cross-sectional observational studies to address a few critical areas of deficiencies related to RF. Firstly, research is needed to discern whether newer pharmacological agents are superior to older therapies during Ramadan. Additionally, more work is needed to assess the impact of fasting on medical complications of diabetes. Finally, guidance is needed on how to best organize healthcare services around Ramadan, including the use of social media to engage patients and support them during Ramadan.

Many studies have assessed physicians' knowledge, attitudes, and practices regarding the impact of Ramadan fasting on diabetes control and how to optimize diabetes management in Ramadan in general and in special groups.[22-26,32] However, to the best of our knowledge, this is the first study that aimed to evaluate physicians' perceptions of RF knowledge gaps, unmet needs, and future research direction. The study findings have important implications for future research and practices in Ramadan. Future trials need to be carefully designed to include data on high-risk groups, important endpoints, and clearly defined outcome measures to address some of the research gaps identified. Additionally, studies should include assessing both the safety and efficacy of different anti-glycemic agents, including the more recently approved agents.

The study has some noteworthy limitations. Although it is widely used, the simple survey design inherently limits the study. Responses reflect physicians' perceptions rather than document their actual clinical practice or academic activities on the ground. However, physicians' appreciation of current gaps and unmet needs are crucial in determining future directions. It has to be acknowledged that the role of patient management in RF is not only limited to physicians but can and should, where appropriate, involve other skilled HCPs such as specialist nurses, dieticians, and pharmacists.[33,34] The current survey does not include the views of non-physician HCPs and is considered a limitation. Moreover, the sample size may have been relatively modest. However, most respondents were experienced physicians, practicing at tertiary centers and academic institutions, putting them in an

ideal position to address some of the scientifically complex and high-level survey questions. Although, we originally targeted senior physicians, we opted to retain the views of the young doctors in training as they were substantial in number and they provide a futuristic views. The lack of previous studies of a similar nature denied us the opportunity to make comparisons and confirm our findings' generalizability. The relatively small sample size and the disproportionate representation of various countries did not allow stratification results by regions. The sampling based on an electronic database held in one region may capture a biased views. A globally-balanced sampling of responses would have given a better representation of the views of physicians caring for large Muslim minorities (eg USA). Nonetheless, most of the themes of the survey are not location-dependent. Future studies should focus on elucidating these findings further and perhaps use face-to-face interviews, focus groups, and Delphi techniques. Also, some of the questions may have been viewed as negatively phrased such as whether Ramadan research is overtaken by industry, and that researchers are personally motivated by their academic interest etc. The authors are fully aware of the Ramadan research scene and lack of support for it. However, we wished to be either neutral or even negative to allow the respondents to express their views. Indeed, it is stronger statement when a respondent disagrees with a statement rather than to agree with it as it was the case here.

5. CONCLUSIONS

The present exploratory study presents the first scoping of physicians' perceptions of knowledge gaps about diabetes and RF and its future research directions. The majority of the respondents conveyed a need for large epidemiological studies and double-blinded, randomized clinical trials to address critical areas of knowledge deficiencies, such as fasting in high-risk groups and technology based-research. Future original research should focus on navigating these complex territories and disseminating its findings via hands-on clinical workshops.

6. DISCLOSURES

Acknowledgment

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Authors' contribution:

All the authors were involved in the study's conceptualization, developing the questionnaire and data collection and analysis. SAB drafted the manuscript, and all authors reviewed it for intellectual content, style, and presentation. They all approved the final version of the article.

Conflicts of interests

No conflicts of interest.

Funding and sponsorship

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Compliance with ethical principles

The study was conducted following the principles of the Declaration of Helsinki. The Institutional Review Board approved it. All participants provided informed consent before they can proceed to the survey questions.

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Legends:

Table 1. Respondents' professional profiles

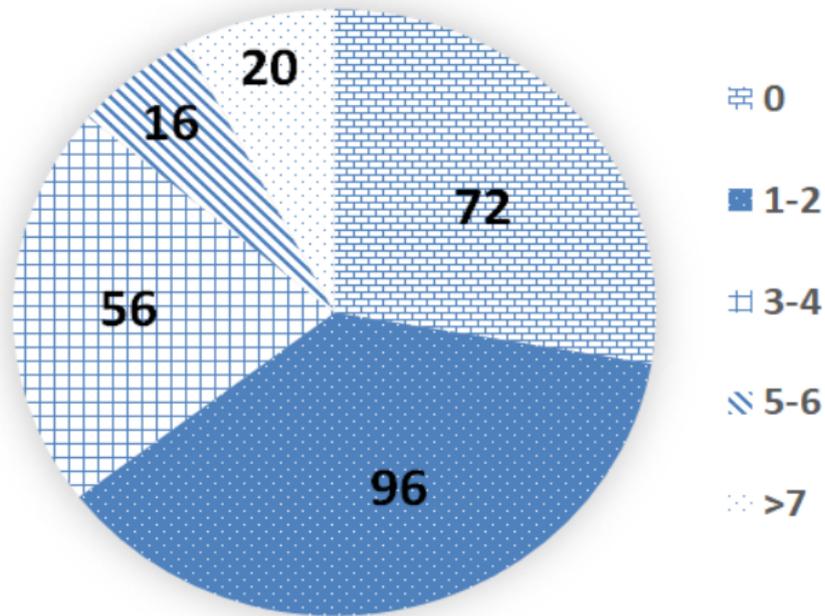
Table 2. Respondents' views on recognized gaps in knowledge and future research questions about the management of diabetes during Ramadan fasting.

Table 3. Respondents' views on future research directions such as methods and publications.

Figure 1. Respondents' participation in Ramadan's professional educational activities (A; upper) and perception of their confidence in managing diabetes during Ramadan (B; lower).

Figure 2. Representation of respondents' views on the status of research interest in diabetes during Ramadan fasting.

A. Respondents' attendance of dedicated "Ramadan and Diabetes" educational activities



B. Respondents' self-reported confidence in management of diabetes during Ramadan.

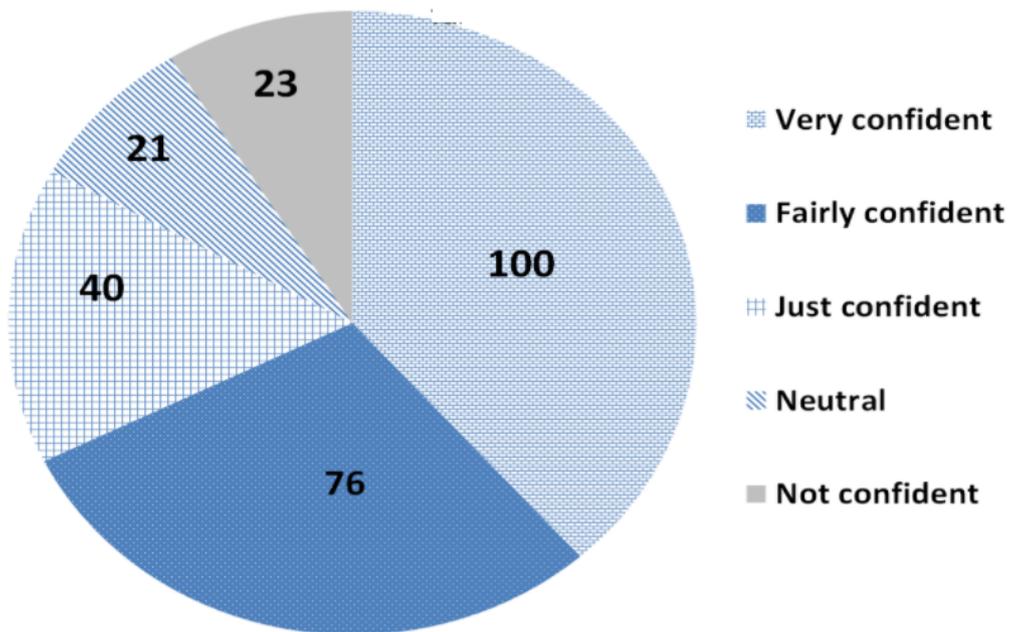


Figure 1. Respondents' participation in Ramadan's professional educational activities (A; upper) and perception of their confidence in managing diabetes during Ramadan (B; lower).

Respondents' views on the status of research interest in diabetes during Ramadan based on the extent of their agreement with the statement: "Relatively, I think there has been reasonably adequate research and publication on managing diabetes during Ramadan fasting"

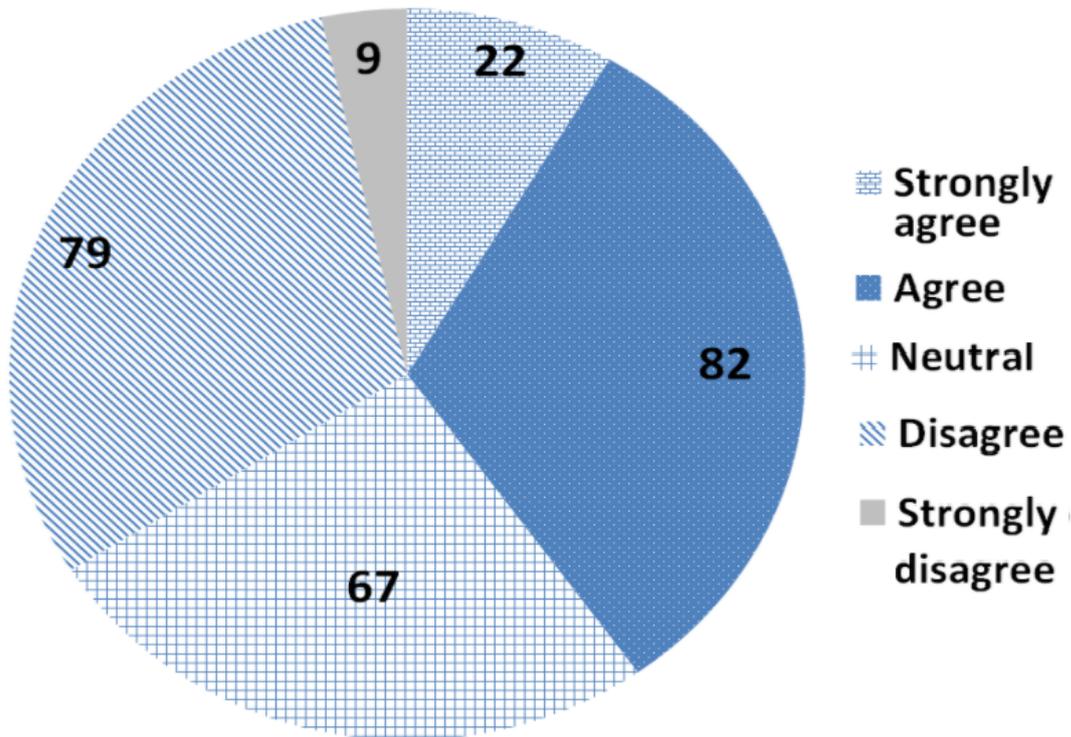


Figure 2. Representation of respondents' views on the status of research interest in diabetes during Ramadan fasting.

Supplementary Material. Appendix 1. The survey questions and potential responses. On physicians' perceptions of the knowledge gaps, unmet needs, and future research directions on the management of diabetes during Ramadan fasting.
I. Consent and respondents' profiles:
*1. Please confirm that you are willing to participate in the study. [<i>Yes, I do agree on the basis of anonymous use; Not this time, but you may come back to me; Not now and never again</i>].
2. Region of the world [<i>Arabian Gulf; Rest of the Middle East; North Africa; Sub-Saharan Africa; South East Asia; Rest of the world</i>].
3. Please state your country of practice: [<i>Free Text</i>].
4. Age (Years) [<i><30; 31-40; 41-50; 51-60; >60</i>].
5. Sex [<i>Man; Woman</i>].
6. Career Stage [<i>Senior (consultant/attending); Middle grade specialist (sub-consultant specialist); Junior (resident in training)</i>].
7. Specialty [<i>Options: primary care/general practice; general internal medicine/geriatric medicine; emergency medicine/Intensive care/hospitalist; obstetrics/gynaecology; adult endocrinology/diabetes; cardiology, nephrology, gastroenterology etc; pediatric endocrinology/diabetes; general pediatrics; surgery (all branches); other (please specify)</i>]
8. Nature of practice [<i>academic/tertiary/referral center; regional hospital; primary care</i>].
9. Type of practice: [<i>Public/Government/State owned services; Specialist services (Police, Military, Employer etc); Private Hospital/Clinic</i>].
10. How many diabetes patients do you see in your practice weekly? [<i>1-10; 11-20; 21-30; 31-40; 41-60; 61-80; 81-100; 101-120; >121</i>]
11. What is the percentage of your patients likely to observe Ramadan fasting? [<i><10%; 11-25%; 26-50%; 51-75%; 76-90%; >90%</i>].
II. Current status of Ramadan research:
12. How many diabetes education workshops dedicated to Diabetes and Ramadan have you attended in the last 2 years (only count sessions of >1 hour) [<i>None; 1-2; 3-4; 5-6; 7-8; 9+</i>]
13. How confident are you in managing diabetes during Ramadan fasting? [<i>Very confident; Fairly confident; Just confident; Neutral; Not very confident; Not at all confident</i>]
14. What "Diabetes and Ramadan" guidelines are you aware of and/or follow? [<i>American Diabetes Association - (Any 2005,2010, 2015 versions) Al Arouj et al. Diabetes Care, Diabetes Canada (Bajaj et al) Canadian Diabetes Journal 2019 British Guidelines - (Ali et al. Diabetic Medicine) ; International Diabetes Federation & DAR Guidelines Hassanein et al Diabetes Research and Clinical Practice, The South Asian Health Foundation (UK) guidelines for managing diabetes during Ramadan. Hanif W. et al. Diabetes Res Clin Pract 2020, South Asian consensus statement on women's health and Ramadan (Bajaj S et al.) Indian J Endocrinol Metab 2012, ISPAD Clinical Practice Consensus Guidelines: Fasting during Ramadan by young people with diabetes. Deeb A et al. Pediatric Diabetes 2020, None - Whatever I learn myself; None - Whatever I pick from educational activities; Other guidelines not mentioned above (please specify)</i>]
15. What do you think of this statement: "Relatively, I think there has been reasonably adequate research and publication on managing diabetes during Ramadan fasting"? [<i>Strongly agree; Agree; Neutral; Disagree; Strongly disagree</i>].
III. Knowledge gaps and unmet needs:
16. What are your views on the following statement regarding the gaps in knowledge on the "Ramadan Fasting and Diabetes Research"? [<i>Grid: Strongly agree; Agree; Neutral; Disagree; Strongly disagree</i>]. [<i>Statements: Inadequate funding to academic centers (ie Universities and Research Centers) in Muslim-majority countries to undertake good quality and unbiased research; lack of proper interest from academic centers (ie Universities and Research Centers) in Muslim-majority countries; Current research is overtaken by the pharma industry to focus on their own specific drugs; Efforts are divided between research groups with more competition than collaborations; "Ramadan Researchers" are motivated by an academic interest in the subject. "Ramadan Researchers" took on the subject</i>

by a personal interest in the subject to advance their academic career at a low cost. "Ramadan Researchers" are encouraged by a financial gain and/or links to the pharmaceutical industry.

17. The following are established gaps in knowledge about the management of diabetes during Ramadan fasting? (Check all possibly correct answers): [Better definition of high/very risk patient grouping; Limited data on high risk patients; Practical management of high risk groups; No evidence base for the risk-stratification; Fasting with diabetes and pregnancy; Optimal use of high technology [Pump, CGMS]; Safety of fasting of old children and adolescents with diabetes; Elaborate on the religious rulings translated into "practical medical terms"; Competence required for diabetes care of Muslim minorities during Ramadan; Safety of Fasting in people with impaired renal function and post transplant; Other (please specify)]

IV. Future research directions:

18. The following are the most appropriate research questions to be addressed to bridge the research gaps? (Check all possibly correct answers) [Are newer pharmacological agents really better than older ones if used correctly?; How to best organize health care before, during and after Ramadan?; What is the value of use of social media in support of people with diabetes fasting during Ramadan? What is the impact of fasting on medical complications of diabetes and how to avoid or reduce this?; What is the knowledge, attitudes and practices of health care professionals in the real world?; What is the knowledge, attitudes and practices of people with diabetes on Ramadan fasting?]

19. What are the most appropriate research methods able to address the unmet needs and unanswered questions? (Check all possibly correct answers) [Cross-sectional observational studies; Double-blind Placebo-controlled trials; Large epidemiological studies; Long term studies; Chart review studies; qualitative studies; Literature-based studies; Survey-type studies on HCP (e.g. KAP studies); Actual Clinical quality assurance studies (audits); Mixed methods studies].

20. The following are the most appropriate article type to address the research gaps? (Check all possibly correct answers) [original research; systematic reviews & meta-analysis; Bibliometric analysis; Narrative reviews; Case reports and case series; Editorials; Invited expert commentaries; Technical reports; Perspectives and viewpoints; Practice Points, info graphs etc; Conference proceedings and highlights; Summaries of workshops; Consensus statements; Focused group discussions (Delphi-type)].

21. The following are the most appropriate communication methods to disseminate research results and good clinical practice guidelines? (Check all possibly correct answers) [International conference; National conference; Regional conference; Workshops "Hands on case discussion/Interactive cases"; Local symposia on focused aspects; Recorded presentations on the internet; Interactive websites; Ramadan sessions built into other events. (like conferences)]

Table 1. The respondents' professional profiles and their practices	
Characteristics (number of respondents per question)	Results [N (%)]
Country distribution of respondents:	
UAE Libya / Pakistan/ Bahrain, UK/Tunisia/ Saudi Arabia, Qatar and Nigeria, Kuwait and Egypt South Africa and Iraq, USA, Oman, Jordan, Canada and Algeria two each from Morocco and Lebanon Turkey, Sudan, Singapore, Mali, Kenya, Ireland, and Bangladesh	63 33/28/26 17/14/11 8 each 7 each 6 each 3 each 2 each One each
Age groups [246]	
<30 years 31-40 years 41-50 years 51-60 years >60 years	22 (8.9%) 56 (22.8%) 74 (30.1%) 56 (22.8%) 38 (15.4%)
Career stage [245]	
Senior (consultant/attending) Middle grade specialist (sub-consultant specialist) Junior (resident in training)	161 (65.7%) 53 (21.6%) 31 (12.1%)
Specialty [244]	
Adult endocrinology/diabetes General/geriatric/hospital/emergency medicine Primary care (family medicine/general practice) Specialist medicine (e.g. cardiology, nephrology, neurology, etc.) Paediatric endocrinology/diabetes Surgery Paediatrics/women's health Other	112 (45.9%) 45 (18.4%) 25 (10.2%) 17 (7.0%) 13 (5.3%) 12 (4.9%) 10 (4.1%) 10 (4.1%)
Nature and type of practice [244; 242]	
Academic/Tertiary referral center Regional hospital Primary care	159 (65.2%) 45 (18.4%) 40 (16.4%)
Public/Government/State-owned services Private hospital/Private clinic Specialized services (police, military, employer-provided, etc.).	173 (71.5%) 64 (26.4%) 5 (2.1%)
Number of patients with diabetes seen in practice weekly [239]	
1-10	43 (18.0%)

11-20	35 (14.6%)
21-40	71 (29.7%)
41-80	45 (18.8%)
>80	34 (18.8%)
Percentage of patients likely to observe Ramadan fasting [238]	
≤10 %	31 (13.0%)
11-25 %	35 (14.7%)
26-50 %	40 (16.8%)
51-75 %	41 (17.2%)
>75%	91 (38.3%)

Table 2. Respondents' views on recognized gaps in knowledge and future research questions about the management of diabetes during Ramadan fasting.			
A. The following are recognized gaps in knowledge about the management of diabetes during Ramadan fasting [244]	Responses [N (%)]*		
Fasting with diabetes and pregnancy	150 (61.5%)		
Safety of fasting in people with impaired renal function & post-transplant	146 (59.8%)		
Practical management of high-risk groups	132 (54.1%)		
Limited data on high-risk patients	120 (49.2%)		
A better definition of high/very risk patient grouping	114 (46.7%)		
Optimal use of high technology [Pump, CGMS]	111 (45.5%)		
Safety of fasting of old children and adolescents with diabetes	111 (45.5%)		
Elaborate on religious rulings translated into "practical medical terms"	87 (35.7%)		
Competence required for diabetes care of Muslim minorities in Ramadan	85 (34.8%)		
No evidence base for the risk-stratification	74 (30.3%)		
B. Respondents' extent of agreement on statements regarding the gaps in knowledge on Ramadan fasting and diabetes research	Strongly agree/agree	Neutral	Strongly disagree / Disagree
Inadequate funding to academic centers in Muslim-majority countries to undertake good quality and unbiased research [239]	181 (75.7%)	48 (20.1%)	10 (4.1%)
Lack of proper interest from academic centers in Muslim-majority countries [240]	155 (64.6%)	54 (22.5%)	31 (12.9%)
Current research is overtaken by the pharma industry to focus on their own specific drugs [241]	150 (62.3%)	62 (25.7%)	29 (12.1%)
Efforts are divided between research groups with more competition than collaborations [238]	139 (58.4%)	76 (31.9%)	23 (9.7%)
"Ramadan Researchers" are motivated by an academic interest in the subject [240]	147 (61.3%)	77 (32.1%)	16 (6.7%)
C. Respondents' views on the most appropriate research questions to be addressed to bridge research gaps	Ranking**		
	1st & 2nd	3rd & 4th	5th & 6th
How to best organize healthcare before, during, and after Ramadan? [190]	95	64	31
Are newer pharmacological agents really better than older ones if used correctly? [186]	92	54	40
What is the impact of fasting on medical complications of diabetes and how to avoid or reduce this? [191]	55	98	35
What is the value of using social media to support people with diabetes fasting during Ramadan? [194]	54	69	67
What is the knowledge, attitudes, and practices of people with diabetes on Ramadan fasting? [202]	45	43	114
What are the knowledge, attitudes, and practices of healthcare professionals in the real world? [186]	32	63	91

* Results are shown as absolute (N) and/or relative frequency (%) to adjust for missing responses. in Section, A. responses are not mutually exclusive.
** Respondents ranked the 6 statements, Rankings are presented in three levels for clarity.

Table 3. Respondents' views on future research directions such as methods and publications.	
Questions and potential responses [n]	Responses*
The most appropriate <u>research methods</u> to address the unmet needs and unanswered questions? [210]	
Large epidemiological studies	104 (49.5%)
Double-blinded placebo-controlled trials	102 (48.6%)
Cross-sectional observational studies	91 (43.3%)
Long term studies	82 (39.0%)
Mixed methods studies	67 (31.9%)
Clinical quality assurance studies	51 (24.3%)
Survey-type studies on HCP	41 (19.5%)
Qualitative studies	35 (16.7%)
Literature-based studies	19 (9.0%)
Chart review studies	18 (8.6%)
The most appropriate <u>type of articles</u> to disseminate knowledge about Ramadan fasting? [210]	
Original research	154 (73.3%)
Systematic reviews & meta-analyses	135 (64.3%)
Consensus statements	76 (36.2%)
Summaries of workshops	65 (31.0%)
Case reports and case series.	55 (26.2%)
Practice points, Infographic, etc	54 (25.7%)
Conference proceedings	52 (24.8%)
Focused group discussions	40 (19.0%)
Invited expert commentaries	39 (18.6%)
Editorials	36 (17.1%)
Perspectives and viewpoints	21 (10.0%)
Narrative reviews	21 (10.0%)
Technical reports	15 (7.1%)
Bibliometric analysis.	9 (4.3%)
The most appropriate venues to disseminate research and good clinical practice guidelines? [209]	
Workshops "Hands-on case discussion/interactive cases"	147 (70.3%)
International conferences	128 (61.2%)
National conferences	120 (57.4%)
Regional conferences	111 (53.1%)
Ramadan sessions built into other professional/academic events.	109 (52.2%)
Local symposia on focused aspects	91 (43.5%)
Interactive websites	89 (42.6%)
Recorded presentations on the internet	74 (35.4%)
* Results are given as frequency and %.	