Review article

Physical activity participation among Arab immigrants and refugees in Western societies: A scoping review

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ABSTRACT

Insufficient physical activity (PA) is the fourth prime risk factor for numerous non-communicable diseases. Arab immigrants and refugees (AIR) are at elevated risk for low or no participation in PA due to socio-cultural and ecological factors. This scoping review examined PA prevalence, knowledge, attitudes as well as barriers vs. facilitators to PA engagement across life domains among AIR in Western countries. A systematic search strategy was implemented across five automated databases (PubMed, Embase, Medline, Sociology Database and Transportation Research Board) to locate pertinent English language papers. Seventy-five articles were included in this study, and stakeholder consultation was conducted to validate the findings. The US and Europe are substantially ahead of Canada, Australia, and New Zealand in AIR-PA research. Despite showing positive attitudes and sound knowledge of PA recommendations, AIR exhibited a low PA engagement prevalence, revealing a knowledge-compliance gap. The prevalence of sufficient PA was lowest in the US (11–22%), whereas Europe showed the highest figures (26–45%). Personal barriers to PA participation involved mainstream language illiteracy and limited exercise skills, whereas improved PA literacy was a significant facilitator. Family responsibility and cultural restrictions were common psychosocial/cultural barriers, whereas social support and culturally-sensitive resources were powerful facilitators. Poorly maintained pedestrian/cyclist infrastructure was a leading environmental barrier amongst AIR in North America, but not Europe. Longitudinal and community-engaged AIR-PA research is needed, and intersectoral collaboration is required to inform tailored interventions and inclusive policies, fostering AIR and other vulnerable populations’ exercise participation and improving their health and well-being.

1. Introduction

Inadequate physical activity (PA) is a major global public health problem and the fourth leading behavioral risk factor for multiple non-communicable diseases (NCDs) such as cardiovascular disease and diabetes (Smith et al., 2017). Adequate PA is defined as weekly participation in ≥150 min of moderate-intensity activity or ≥75 min of vigorous-intensity activity or an equivalent combination of both (WHO, 2019a). Globally, approximately 3.2 million deaths and 13.4 million disability-adjusted life-years (DALYs) are attributable to inadequate PA annually (WHO, 2019b). North America and Europe experience annual physical inactivity related DALYs of about 1.1 and 2.3 million, respectively. In 2013, the annual total health care and societal costs of physical inactivity exceeded international $28.5 and $15.5 billions in North America and Europe, respectively (Ding et al., 2016).

Immigrants are at elevated risk for low/no participation in PA across life domains (occupational or work-related PA, domestic or housework-related PA, transportation-related or transport PA (TPA), and recreational or leisure-time PA (LTPA)), due to socio-economic and ecological influences (Kobrosly, 2019). Reduced participation in adequate PA likely contributes to the observed decline in the physical and mental health of initially healthy immigrants, which is known as “the Healthy Immigrant Effect” (Newbold, 2006). The numbers of Arab immigrants and refugees (AIR) in Western countries have been increasing exponentially due to political/economic instability in the Arab world (Sweileh, 2018). There are about 4.6 million AIR in North America, and

Abbreviations: AIR, Arab immigrants and refugees; DALYs, disability-adjusted life-years; LTPA, leisure time physical activity; NCDs, non-communicable diseases; PA, physical activity; TPA, transport physical activity.

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0.3 million in Australia and New Zealand, constituting around 1.3 and 1.2% of the total populations, respectively (Arab American Institute (AAI), 2018; ABS, 2017; Statistics Canada, 2019; Statistics NZ, 2019). France, Germany and the UK are the leading AIR-receiving European countries, hosting about 7.7 million AIR that collectively represent around 3.5% of these nations’ population (Insee, 2015; NABA, 2013; Statista, 2018).

Insufficient PA participation is of particular concern among AIR who embody distinct cultural beliefs/values and previously lived in socio-physical environments that spontaneously enhanced their PA levels through, for example, limited access to labor-saving devices, high social capital, and accessibility of farmlands (Eldoumi and Gates, 2019). In leisure time, AIR would rely on active commuting (walking) to visit their neighbors/friends in their home country (Wilson and Renzaho, 2015). Different neighborhood features in Western countries (e.g., poor weather conditions, reliance on personal automobiles) may be associated with reduced PA participation and sedentary behavior among AIR as compared to other immigrant groups and the broader population. For instance, AIR in the US exhibited significantly lower sufficient PA prevalence compared to white, non-Hispanic immigrants (11 vs. 19%, respectively) (Snyder et al., 2013). In Sweden, the prevalence of adequate LTPA was lowest among AIR (50%) relative to Yugoslavian (62%) and Polish (69%) immigrants as well as the Swedish majority population (91%) (Lindström and Sundquist, 2001). Furthermore, AIR in England showed considerably lower prevalence of sufficient total PA than the general population (38 vs. 71%, respectively) (McEwen et al., 2008).

Despite the well-established benefits of PA for reversing the trends of declining health in the years following immigration, there is a gap in the present knowledge of the trends and factors influencing AIR’s PA participation. Previous reviews on immigrants’ PA lacked the adoption of a systematic search strategy, and included different ethnic/culturally diverse immigrants (e.g., Latino, Asians and Arabs), which may have affected the comparability of the results (Capernchione et al., 2009; Langsien et al., 2017). El Masri et al. (2021) conducted an AIR-specific systematic review to explore factors influencing AIR’s PA participation, however, the review only synthesized the qualitative evidence. Furthermore, El Masri et al. (2021) did not address the impact of detected factors on different PA domains, which is crucial to design effective PA interventions.

This scoping review aims to thoroughly investigate AIR’s PA prevalence (i.e., proportion of AIR who engage in sufficient PA) and influences affecting their PA participation to direct future AIR-PA research and evidence-informed interventions. This review’s particular objectives are to: 1) examine AIR’s PA prevalence across different domains, 2) investigate AIR’s perceptions, knowledge, preferences and attitudes towards PA, and 3) explore barriers vs. facilitators to AIR’s PA participation.

2. Methodology

This study employed a scoping review methodology to examine the range/scope of the available literature on AIR’s PA participation, producing a thorough synthesis of the existing pertinent evidence and identifying the current gaps in knowledge/research. The six-stage scoping framework delineated by Arksey and O’Malley (2005) was exploited, while following PRISMA guidelines (Tricco et al., 2018).

2.1. Formulating the research question

The following review question was developed to scope the literature: What are the physical activity prevalence and factors influencing physical activity participation by Arab immigrants/refugees in Western societies?

2.2. Searching for relevant studies

A systematic search strategy was developed and implemented by two authors (SE and BN) to locate pertinent records. Within the research question, three main concepts were determined: physical activity, Arab and immigrant. Five electronic databases (PubMed, Embase, Medline, Sociology Database and Transportation Research Board) were searched from inception (1950s, 1974, 1946, 1985 and 1922, respectively) to February 2020, using seventy-five search terms/phrases (Appendix A). A manual search of other sources (Google Scholar, eligible papers’ reference lists and first/corresponding authors) was also conducted.

2.3. Study selection

The following inclusion and exclusion criteria were employed to screen titles/abstracts of all returned articles and assess potentially pertinent articles (Fig. 1). Only English articles from Europe, North America, Australia, or New Zealand were included. Studies were considered eligible if they addressed PA prevalence, knowledge, perceptions, preferences, attitudes, or barriers vs. facilitators to PA participation among AIR. All study designs and age/gender groups were eligible and either subjectively or objectively assessed PA (across all domains) were included. Theses/dissertations were eligible for inclusion. Only studies of AIR from any of the 22 Arab league nations were eligible (World Population Review, 2020). Studies investigating epidemiology of NCDs linked to physical inactivity or associations between PA and obesity/insulin sensitivity were excluded.

Discussions were held to tackle any disagreements between the authors.

2.4. Data charting

A charting tool, specifically developed in Microsoft Excel for the purpose of this study, was used to extract pertinent data from the eligible articles. This involved authorship, study design, investigated PA domains, AIR participants, destination countries, and key findings.

2.5. Evidence synthesis and reporting of findings

All data were numerically synthetized to reveal any research gaps and to facilitate effective reporting. Three major themes were established to categorize the extracted data and explicitly address the review’s objectives. In order to help make the findings beneficial for future PA research, policymaking and practice, the study’s implications were also addressed.

2.6. Consulting stakeholders

A consultation was conducted with six stakeholders providing fitness/PA services to AIR in North America and Europe to validate the review’s findings and link research to practice. Three stakeholders are based in Canada, with two of them additionally providing online fitness services to AIR in the US and Europe (Table 1).

About 80% of the consultants are females. A convenience sampling technique was employed to select the consulted individuals. Eligibility criteria involved possessing a minimum of three-year experience in providing fitness/PA services to AIR in Western countries. The consultation exercise started with virtually presenting the review’s aim/objectives, methods and main findings. This was followed by the consultants filling out a short survey that explored their professional perspectives about the study’s findings. The consultation’s output was considered through an informative summary within this scoping study’s results. Ethical clearance was granted by the University Ethics Board and all consultants provided informed voluntary consent.
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3. Results

3.1. Characteristics of the eligible studies

In total, 2766 records were returned from the database search, besides 21 additional articles found through the manual search. Seventy-five articles were included (Fig. 1). Most studies were performed in the US (44%) and Europe (36%) (Appendix B). Around 41% of the studies recruited AIR from mixed Arabic countries. Somalia was the most common country of origin (28%), followed by Iraq (12%). Over half of the studies (53%) employed qualitative methods. About 90% of the eligible quantitative studies employed a cross-sectional design. LTPA was the most commonly explored PA domain (65%), followed by TPA (47%). Only a quarter of the studies that measured PA used objective methods.

3.2. PA prevalence

Forty-one studies examining AIR’s PA prevalence were included. These explored prevalence of total PA and separate PA domains.

3.2.1. Total PA

AIR exhibited a low prevalence of adequate total PA (Table 2). In Europe, the prevalence of AIR’s participation in sufficient PA was in the range of 26–45% on self-reporting and 11–17% when assessed objectively. The prevalence of adequate PA among AIR in Australia was assessed in only two studies by Alzubaidi et al. (2015) and Astell-Burt et al. (2013), showing relatively higher results (35 and 66%, respectively). AIR in the US, on the other hand, exhibited the lowest prevalence of sufficient self-reported total PA (11–22%). Only two studies compared the prevalence of both subjectively and objectively measured PA, revealing significant differences (34 vs. 17% and 22 vs. 6%, respectively) (Alasagheirin and Clark, 2017; Arvidsson et al., 2013). Finally, AIR living in the US and Australia considered themselves sedentary/not doing enough PA (Berggren et al., 2017; Caperchione et al., 2011; Tami et al., 2012; Wilson and Renzaho, 2015).

3.2.2. Separate PA domains

Across Western countries, AIR reported low prevalence of sufficient domain-specific PA (Table 2). AIR women in Europe reported the lowest prevalence of sufficient LTPA (25–32%) (Hosper et al., 2008). Two Swedish surveys revealed that AIR women had significantly lower sufficient LTPA prevalence (self-reported), relative to AIR men (30 vs. 52% and 32 vs. 63, respectively) (Lecerof et al., 2011; Lindström and Sundquist, 2001). Likewise, qualitative studies showed that AIR women did not (or slightly) participate in LTPA (Devlin et al., 2011; Eldoumi, 2017; Gele et al., 2015; Marinescu et al., 2013; Persson et al., 2014; Guerin et al., 2003). AIR women also felt that they do not do enough domestic PA (Sulaiman et al., 2007).

3.3. Knowledge, preferences and attitudes

This theme included 32 articles addressing AIR’s knowledge and attitudes to PA participation. These were extensively discussed under three subthemes: knowledge/perceptions, PA preferences and attitudes/perceived benefits.

3.3.1. Knowledge and perceptions

Qualitative studies revealed a sound knowledge of PA recommendations for health among AIR (Berggren et al., 2017; Olaya-Contreras et al., 2019), though El Masri et al. (2020) found limited awareness.

Table 1

| Consultant number | Gender | Current location | Other notes |
|-------------------|--------|------------------|-------------|
| Consultant 1      | Male   | Ontario, Canada  | Online fitness services to AIR in other provinces in Canada and the US |
| Consultant 2      | Female | Alberta, Canada  | Online fitness services to AIR in other provinces in Canada, the US and Europe |
| Consultant 3      | Female | Ontario, Canada  | Online fitness services to AIR in other provinces in Canada, the US and Europe |
| Consultant 4      | Female | ROI/Northern Ireland | Previous experience with AIR in England |
| Consultant 5      | Female | ROI/Northern Ireland | N/A |
| Consultant 6      | Female | England, UK      | N/A |
| Frequency         | Male: Canada: ROI: | (17:83) | England: ROI: | (50:33:17) |

Abbreviations: AIR: Arab immigrants and refugees; N/A: non-available; ROI: Republic of Ireland.
Western societies makes any performed PA worthless for health. AIR lacked knowledge of exercise/fitness equipment (Devlin et al., 2012; Persson, 2015; Qahoush, 2006; Wieland et al., 2011). Healthcare providers were the main source of PA information. AIR in Sweden were able to distinguish between types of moderate PA (e.g., walking) and vigorous PA (e.g., hiking uphill) (Lecerof et al., 2011). AIR adults, nonetheless, were unfamiliar with PA participation beyond the work, domestic or transport domains (Caperchione et al., 2011; Niccolau et al., 2012; Persson et al., 2014). AIR lacked knowledge of necessary skills to engage in different LTPA types (e.g., gymnastics) and were unfamiliar with exercise/fitness equipment (Devlin et al., 2012; Eldoumi, 2017; Kahan, 2011; Marinescu et al., 2013; Njeru et al., 2016; Södergren et al., 2010). On the other hand, AIR youth were knowledgeable of the skills required to participate in different sports (e.g., soccer) (Berggren et al., 2017; Rothe et al., 2010).

AIR perceived exposure to the sun to be essential to benefit from any perceived PA as protective against depression. Improved self-confidence was perceived as a mental health benefit. Around 40% of AIR participants of a study by Eldoumi (2017) recognized PA as beneficial for physical health and mental/psychosocial wellbeing (El Masri et al., 2020) (Table 3).

### Table 2

| Author, date          | Study design | AIR participants’ characteristics, destination & native countries | PA tool                        | Assessed PA domain | Prevalence a, b |
|-----------------------|--------------|---------------------------------------------------------------|-------------------------------|--------------------|-----------------|
| Alasagheirin and Clark, 2017, 2018 | CSS          | 54 children, 61% girls, T age = 10.1, US, Sudan           | PAQ-C & pedometer               | Total PA            | 22%             |
| Alzubaidi et al., 2015 | CSS          | 393 adults, 50% F, T age = 58, Australia, mixed              | Self-reported questionnaire    | Total PA            | 35%             |
| Arvidsson et al., 2013 | CSS          | 599 adults & elderly, 58% M, T age = 47, Sweden, Iraq       | Self-reported questionnaire & accelerometry | Total PA            | 34%             |
| Arvidsson et al., 2015 | CSS          | 493 adults & elderly, 58% M, T age = 46, Sweden, Iraq       | Accelerometry                  | Total PA            | 17%             |
| Antell-Burt et al., 2013 | CSS          | 978 adults aged ≥45, Australia, Lebanon                       | Self-reported questionnaire     | Total PA            | 66%             |
| Gele and Mbhali, 2013 | CSS          | 208 adults, 55% F, Norway, Somalia                           | IPAQ                           | Total PA            | 41%             |
| Jonsson et al., 2012  | CSS          | 525 adult women, 40% aged 18–34, Sweden, Iraq               | IPAQ                           | LTPA               | 27%             |
| Kahan, 2007            | CSS          | 214 adult students, 54% F, T age = 21, US, mixed             | Pedometer                      | Total PA            | 36%             |
| Kahan, 2009            | CSS          | 214 adult students, 54% F, T age = 21, US, mixed             | Pedometer                      | Total PA            | 36%             |
| Lecerof et al., 2011   | CSS          | 579 adults, 53% F, 50% aged 27–42, Sweden, Iraq             | Self-reported questionnaire     | LTPA               | 40%             |
| Lindstrom and Sundquist, 2001 | CSS        | 101 adults & elderly, 56% F, Sweden, mixed                  | Self-reported questionnaire     | LTPA               | 44%             |
| Maki-Opas et al., 2014 | CSS          | 476 adolescents, T age = 14–4, Netherlands, Morocco          | Self-reported questionnaire     | LTPA, TPA           | 39, 33%         |
| Mcewen et al., 2008    | CSS          | 62 adults, UK, Somalia                                       | Self-reported questionnaire     | Total PA            | 38%             |
| Qahoush et al., 2010   | CSS          | 180 adult women, Tge = 37.6, US, mixed                       | IPAQ                           | Total PA, OPA       | 44, 33%         |
| Sarsour et al., 2010   | CSS          | 353 adults (90%) & elderly, 57% F, US, mixed                 | Self-reported questionnaire     | Total PA            | 11%             |
| Siddiqui et al., 2017  | RCT          | 96 adults, 53% F, T age = 48, Sweden, Iraq                  | IPAQ                           | Total PA            | 45%             |
| Snyder et al., 2013    | CSS          | 456 adults (90%) & elderly, 48% F, US, mixed                 | Self-reported questionnaire     | Total PA            | 11%             |
| Södergren et al., 2010 | CSS          | 553 adult women, T age = 43, Sweden, Iraq                    | IPAQ                           | Total PA            | 35%             |
| Torp et al., 2015      | CSS          | 114 adults, T age = 35, Sweden, Somalia                      | IPAQ                           | Total PA            | 26%             |

Abbreviations: AIR: Arab immigrants and refugees; CSS: cross-sectional study; F: females; IPAQ: international physical activity questionnaire; LTPA: leisure-time physical activity; M: males; OPA: occupational physical activity; PA: physical activity; PAQ-C: physical activity questionnaire for children; RCT: randomized controlled trial; TPA: transport physical activity; TPA: total physical activity.

Healthcare providers were the main source of PA information. AIR in Sweden were able to distinguish between types of moderate PA (e.g., walking) and vigorous PA (e.g., hiking uphill) (Lecerof et al., 2011). AIR adults, nonetheless, were unfamiliar with PA participation beyond the work, domestic or transport domains (Caperchione et al., 2011; Niccolau et al., 2012; Persson et al., 2014). AIR lacked knowledge of necessary skills to engage in different LTPA types (e.g., gymnastics) and were unfamiliar with exercise/fitness equipment (Devlin et al., 2012; Eldoumi, 2017; Kahan, 2011; Marinescu et al., 2013; Njeru et al., 2016; Södergren et al., 2008). On the other hand, AIR youth were knowledgeable of the skills required to participate in different sports (e.g., soccer) (Berggren et al., 2017; Rothe et al., 2010).

AIR perceived exposure to the sun to be essential to benefit from any undertaken PA through sweating and recognized that cold weather in Western societies makes any performed PA worthless for health (Berggren et al., 2017; Devlin et al., 2012, 2011; Mcewen et al., 2008).

#### 3.3.2. PA preferences

Walking was the most preferable PA type among AIR (Berggren et al., 2017; Eldoumi, 2017; Persson et al., 2014; Wieland et al., 2015, 2013). About 80% of women participants of an American survey by Qahoush et al. (2010) cited walking as the most favorable type of PA for transportation and leisure. AIR women delineated that walking was the most familiar PA that requires no specific skills, besides being cost-free and culturally acceptable (Eldoumi and Gates, 2019; Sulaiman et al., 2007). AIR women mentioned that swimming, cycling, gymnastics and dancing would be preferable LTPA if they received adequate training by women coaches/trainers (Persson, 2015; Qahoush, 2006; Wieland et al., 2011). Basketball, soccer and sledding were the most favorable PA options among AIR children (Rothe et al., 2010).

#### 3.3.3. Attitudes and perceived benefits

AIR exhibited positive attitudes towards PA (Eldoumi, 2017; Greves et al., 2007; Wieland et al., 2015, 2013). AIR expressed motivation to learn/develop different LTPA skills/techniques to increase their exercise levels (Berggren et al., 2017; Kay, 2006; Olaya-Contreras et al., 2019). Approximately 96% and 78% of participants in studies by Guerin et al. (2003) and Eldoumi and Gates (2019), respectively, were motivated to improve their exercise skills and engage in more LTPA.

AIR perceived PA as beneficial for physical health and mental/psychosocial wellbeing (El Masri et al., 2020) (Table 3).

Prevention of cardiovascular disease and diabetes was the most common perceived physical health benefit. AIR realized the importance of PA for weight management/loss. AIR considered PA to be useful for enhancing blood circulation and in turn, improving their cognitive functioning. Increasing life expectancy was among the perceived benefits of PA. Distress management, enhancing quality sleep, and depression prevention were the most commonly perceived mental health benefits. Around 40% of AIR participants of a study by Eldoumi (2017) recognized PA as protective against depression. Improved self-confidence was a commonly perceived psychosocial benefit of PA. AIR perceived participation in structured exercise/fitness classes to be helpful for their integration into the mainstream society.

#### 3.4. Barriers and facilitators to PA

This theme involved 60 articles addressing 21 barriers and 15 facilitators to PA participation. These were categorized into three main
3.4.2. Psychosocial and cultural factors

Pressure barrier was mentioned by around 60% of the participants in motivation fostered AIR critical for LTPA, whose related training (e.g., controlling treadmill). Additional major barriers that hindered AIR were non-trauma, which were common barriers to LTPA. This was particularly amongst AIR (Snyder et al., 2013). Poor physical health limited AIR leaving their kids during PA participation (Table 4).

Improvement of PA skills/literacy through PA training sessions/education programs in AIR’s native language was a major facilitator to LTPA and TPA (Table 4). Improved PA skills/literacy through PA training sessions/education amongst AIR women who wore the visible hijab (a veil worn by Muslim women). Social/family support was a major facilitator that enhanced AIR’s LTPA and TPA participation through various pathways, including companionship when exercising, looking after each other’s children and having supportive family members that encourage active living (Table 5). Perceived social support was a significant positive predictor for LTPA among AIR in Canada (Kobrosly, 2019). Similarly, parental support was significantly positively associated with LTPA and TPA among AIR children in Europe (Labree et al., 2014). Provision of culturally acceptable programs was a powerful facilitator to LTPA. Finally, wider community cohesion enhanced AIR’s LTPA and TPA participation through increasing social capital (e.g., spreading the word about available resources, creating community-based carpooling and organizing community walking/cycling groups).

3.4.3. Neighborhood environment factors

Overreliance on vehicles and telephones in Western countries was a major barrier to TPA among AIR, who previously relied on active commuting for communication with their relatives/friends, living within a walking distance in their home countries (Table 4). Overdependence on labor-saving devices (e.g., vacuum cleaners) was also a major barrier to domestic PA. Poor weather conditions and lack of safety from crime, traffic and dog attacks were key barriers to TPA and outdoor LTPA. Inaccessibility of leisure facilities/parks and strict child policy, restricting children’s outdoor play without close supervision, were major barriers to LTPA and their children. Inaccessible transportation systems hindered AIR’s attendance of LTPA classes/programs, whereas inaccessible community services (e.g., schools, malls) minimized their TPA participation. Poorly maintained pedestrian/
Table 4
Barriers to physical activity participation across different domains amongst Arab immigrants/refugees.

| Author, date | Study design | AIR participants’ characteristics, destination & native countries | Personal & AIR’s socioeconomic & health issues | Psychosocial & cultural issues | Neighborhood environment |
|-------------|-------------|--------------------------------------------------|-----------------------------------------------|---------------------------------|-------------------------|
| Abou-Rizk and Rail, 2013 | QI | 20 F aged 18–25, Canada, Lebanon | L, T | L | O |
| Berggren et al., 2017 | QF | 13 adults aged ≥18, 62% F, US, Somalia | L, T | L, T | T |
| Caperchione et al., 2011 | QF | 29 adult F, age = 39, Australia, mixed | L, T | L, T | T |
| Dagkas and Benn, 2006 | QI | (NA) F aged 13–21, UK, mixed | L, T | L, T | T |
| Dawson-Hahn et al., 2020 | QF | 27 adult parents, US, mixed | L, T | L, T | T |
| Devlin et al., 2012, 2011 | QF | 30 adult F, age = 39, US, Somalia | L, T | L, T | T |
| Eldoumi, 2017 | MM | 447 mothers aged 18–40, US, mixed | L, T | L, T | T |
| El Masri et al., 2020 | QF | 28 adults, 71% F, age = 45, Australia, mixed | L, T | L, T | T |
| El Masri et al., 2021 | SR | 15 studies of adult AIR | L, T | L, T | T |
| Gele et al., 2015 | QI | 30 adult F aged ≥25, Norway, Somalia | L, T | L, T | T |
| Greves et al., 2007 | QF | 18 adults, US, Somalia | L, T | L, T | T |
| Guerin et al., 2003 | QI | 27 adult F, age = 33, NZ, Somalia | L, T | L, T | T |
| Halliday et al., 2014 | QF | 33 adults/adolescents, Australia, Somalia | L, T | L, T | T |
| Hamzeh and Oliver, 2012 | QI | 3 girls aged 14–17, UK, mixed | L, T | L, T | T |
| Hashimoto-Govindasamy and Rose, 2011 | QI | 12 adult F, age = 31, Australia, Sudan | L, T | L, T | T |
| Hosper et al., 2008 | CSS | 170 F aged 15–30, Netherlands, Morocco | L, T | L, T | T |
| Husien, 2007 | CSS | 60 adult F, age = 39, Canada, mixed | L, T | L, T | T |
| Jadalla et al., 2015 | CSS | 297 adults, 56% F, age = 39, US, mixed | L, T | L, T | T |
| Jonsson et al., 2012 | CSS | 525 adult F aged ≥18, Sweden, Iraqi | L, T | L, T | T |
| Kahan, 2009 | CSS | 214 adults, 54% F, age = 21, US, mixed | L, T | L, T | T |
| Kahan, 2011 | QI | 21 adults, 57% F, age = 22, US, mixed | L, T | L, T | T |
| Kay, 2006 | QI | 1 girl, UK, NA | L, T | L, T | T |
| Kobrosly, 2019 | CSS | 376 adults (96%) & elderly, 55% M, Canada, mixed | L, T | L, T | T |
| Lunn, 2014 | MM | 145 adults, 47% F, age = 35, US, Somalia | L, T | L, T | T |
| Marinescu et al., 2013 | QF | 12 F, US, Somalia | L, T | L, T | T |
| McEwen et al., 2008 | QF | 65 adults, UK, Somalia | L, T | L, T | T |

(continued on next page)
| Author, date | Study design | AIR participants’ characteristics, destination & native countries | Personal & AIR’s socioeconomic (A) Language issues, (B) Unawareness of available resources, (C) Limited PA skills, (D) Poverty/financial issues & unemployment, (E) Low education, (F) Low self-efficacy/motivation, and (G) Physical health issues | Psychosocial & cultural (A) Time pressures & familial responsibility, (B) Discrimination/racism, (C) Cultural restrictions, and (D) Low social support | Neighborhood environment (A) Poorly-maintained infrastructure, (B) Inaccessible community services, (C) Inaccessible transport, (D) Inaccessible leisure amenities/parks, (E) Strict child policy, (F) Lack of safety, (G) Poor weather (H) Overreliance on technology, (I) Small size housing, & (J) Inaccessible urban farms |
|--------------|--------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| Mohamed et al., 2014; Mohamed et al., 2012 Mude and Mwaniki, 2016 | QIF | 20 adult M aged ≥24, US, Somalia | L, T | L, T | L, T | L, T | L, T | L, T |
| | | 8 adult parents, 60% F, Australia, Sudan | L, T | L, T | L, T | L, T | L, T | L, T |
| Murray et al., 2015 | PV | 8 adult F, 60% F, US, Somalia | L, T | L, T | L, T | L, T | L, T | L, T |
| Murray et al., 2017 | QF | 40 adult F, 60% F, US, Somalia | L, T | L, T | L, T | L, T | L, T | L, T |
| Nakamura, 2002 Nicolaou et al., 2012, 2011 | QF | 1 adult F, Canada, Lebanon | L, T | L, T | L, T | L, T | L, T | L, T |
| | | 22 AIR aged 16–48, Netherlands, Morocco | L, T | L, T | L, T | L, T | L, T | L, T |
| Njeru et al., 2016 | QI | 39 adults, 62% F, 33 adults, 62% F, 53, US, Somalia | To | To | To | To | To | To |
| Perna et al., 2019 Olaya-Contreras et al., 2019 | QF | 33 adults, 58% F, 33 adults, 58% F, 53, Sweden, Iraq | L, T | L, T | L, T | L, T | L, T | L, T |
| Persson et al., 2014 | QF | 26F aged 17–67, 54% married, Sweden, Somalia | L, T | L, T | L, T | L, T | L, T | L, T |
| Qahoush et al., 2010 | CSS | 180 adult F, 37.6, US, mixed | To | To | To | To | To | To |
| Renuzho et al., 2011 Rothe et al., 2010 | QIF | (NA) adults & adolescents, | L, T | L, T | L, T | L, T | L, T | L, T |
| | | 84% F, 83%, 84%, Australia, mixed | L, T | L, T | L, T | L, T | L, T | L, T |
| Sidiqqui et al., 2018 Snyder et al., 2013 | RCT | 56 AIR aged 30–75, Sweden, 180 adults F, 37.6, US, mixed | L, T | L, T | L, T | L, T | L, T | L, T |
| | | 456 adults & elderly, 48%, 53, US, mixed | L | L | L | L | L | L |
| Södergren et al., 2008 Sulaiman et al., 2007 | QF | 23F aged 28–61, Sweden, Iraq | L, T | L, T | L, T | L, T | L, T | L, T |
| | | 20 adults & elderly, 58.8%, 84%, Australia, mixed | L | L | L | L | L | L |
| Wieland et al, 2011 Wieland et al, 2015, 2013 | MM | 14 adult F aged ≥22, US, Somalia | L, T | L, T | L, T | L, T | L, T | L, T |
| | | 62 adults & adolescents, 47% F, US, mixed | L | L | L | L | L | L |
| Wilson and Renzaho, 2015 | QF | 31 adults & adolescents, Australia, mixed | L | L | L | L | L | L |

D: barrier to domestic physical activity; L: barrier to leisure-time physical activity; O: barrier to occupational physical activity; T: barrier to transport physical activity; To: barrier to total physical activity. Abbreviations: AIR: Arab immigrants and refugees; CSS: cross-sectional study; F: females; M: males; MM: mixed method; NA: non-available; PA: physical activity; PV: photo voice; QF: qualitative focus groups; QI: qualitative interviews; QIF: Mixed qualitative interviews and focus groups; RCT: randomized controlled trial; SR: systematic review; mean age. * AIR from mixed Arab countries.
Table 5  
Facilitators to physical activity participation across different domains amongst Arab immigrants/refugees.

| Author, date | Study design | AIR participants’ characteristics, destination & native countries | Personal & AIR’s socioeconomic | Psychosocial & cultural | Neighborhood environment |
|--------------|--------------|-----------------------------------------------------------------|---------------------------------|------------------------|--------------------------|
|              |              |                                                                  | (A) Improved PA skills/literacy, (B) Perceived health benefits, & (C) Motivation & self-efficacy | (A) Social/family support, (B) Wider community cohesion, & (C) Culturally relevant programs | (A) Well-maintained infrastructure, (B) Pleasant surroundings (C) Community resources proximity, (D) Childcare facilities accessibility (E) Efficient transport, (F) Leisure amenities/parks accessibility, (G) PA resources databases, & (H) Safety measures |
| Abou-Rizk & Rail, 2013 | QI | 26F aged 18–25, Canada, Lebanon MM 145 adults, 47% F, M | L | To | L |
| Aguash, 2007; Aguash & Van Servellen, 2013 | CSS | 120 adults & elderly, 59% M, age = 42, 89% married, US, mixed | | | |
| Berggren et al., 2017 | QIF | 13 adults aged ≥18, 62% F, US, Somalia | L | To | I, L, T | |
| Caperchione et al., 2011 | QF | 29 adult F, age = 39, Australia, mixed | L | To | I, L, T | L |
| Dagkas and Benn, 2006 | QIF | (NA) F aged 13–21, UK, mixed | L | | L |
| Devlin et al., 2012, 2011 | QF | 30 adult F, age = 39, US, Somalia | L | L | L |
| Eldoumi, 2017 | MM | 447 mothers aged 18–40, US, mixed | L | To | To, L |
| El Masri et al., 2020 | QF | 28 adults, 71% F, age = 45, Australia, mixed | L | To | To, L |
| El Masri et al., 2021 | SR | 15 studies of adult AIR | L | To | L |
| Gele et al., 2015 | QI | 30 adult F aged ≥25, Norway, Somalia | L | L | L |
| Greves et al., 2007 | QF | 18 adults, US, Somalia | L | To | L |
| Guerin et al., 2003 | QI | 27 adult F, age = 33, NZ, Somalia | L | L | T |
| Halliday et al., 2014 | QF | 33 adults/adolescents, Australia, Somalia | L | L | L |
| Hashimoto-Govindanayana, & Ross, 2011 | QI | 12 adult F, age = 31, Australia, Sudan | L | L | L |
| Hosper et al., 2008 | CSS | 170F aged 15–30, Netherlands, Morocco | L | L | L |
| Kahan, 2011 | QF | 21 adults, 57% F, age = 22, US, mixed | L | L | T |
| Kay, 2006 | QI | 1 adolescent girl, UK, NA | L | L | L |
| Kobrutsy, 2019 | CSS | 37% adults (96%) & elderly, 55% M, Canada, mixed | L | L | L |
| Labree et al., 2014 | CSS | 66 children, 56% M, age = 9, Netherlands, Morocco | L | L | L |
| Lunn, 2014 | MM | 145 adults, 47% F, age = 35, US, Somalia | L | L | L |
| Maki-Opas et al., 2014 | CSS | 46% children, age = 14, Morocco, Lebanon | L | L | T |
| Marinescu et al., 2013 | QF | 12F, US, Somalia | L | L | L |
| Martin et al., 2008 | CSS | 348 children, 51% F, age = 12, US, mixed | L | L | L |
| Mejean et al., 2009 | LS | 147 adult M, age = 50, France, Tunisia | L | L | L |
| Mohamed et al., 2014 | QIF | 20 adult M aged ≥24, US, Somalia | L | L | L |
| Murray et al., 2015 | PV | 8 adult F, age = 46, US, Somalia | L | L | L |
| Murray et al., 2017 | QF | 40 adult F, age = 46, US, Somalia | L | L | L |
| Nakamura, 2002 | QI | 1 adult F, Canada, Lebanon | L | L | L |
| Nicolaou et al., 2012 | QF | 22 aged 16–48, Netherlands, Morocco | L | L | L |
| Olawa-Contraseras et al., 2019 | QF | 33 adults, 58% F, Sweden, Iraq | L | L | L |
| Persson, 2015 | QF | 26F aged 17–67, Sweden, Somalia | L | L | L |
| Qahoush et al., 2010 | CSS | 180 adult F, age = 37.6, US, mixed | L | L | L |
| Renzaho et al., 2011 | QIF | (NA) adults/adolescents, Australia, mixed | L | L | L |
| Rothe et al., 2010 | QF | | L | L | L |

(continued on next page)
cyclist infrastructure were common barriers to TPA and leisure walking/cycling among AIR in North America. Inaccessibility of urban farms was a common barrier to occupational PA among AIR who previously relied on farming as a means of income in their native countries. Finally, living in non-spacious houses/apartments minimized AIR’s domestic PA.

Accessibility of recreational amenities/parks was a major facilitator to LTPA participation (Table 5). A Dutch survey by Labree et al. (2014) showed a significant positive association between availability of affordable sports clubs and LTPA among AIR. Availability of free community bicycles enhanced transport cycling among AIR in England (Witty-Merrin et al., 2018). Accessibility of child-minding facilities facilitated AIR women’s participation in TPA and LTPA. Proximity to community services enhanced AIR’s active commuting. Availability of safety measures (e.g., dog free areas, police patrol/crossing guards) and pedestrian/cyclist-friendly infrastructure (e.g., cycle lanes, sidewalks) were common facilitators to AIR’s TPA and outdoor LTPA. Efficient transport networks enhanced AIR’s participation in LTPA programs. AIR suggested that the presence of accessible community databases for available PA resources/facilities would help increase their TPA and LTPA levels (Murray et al., 2015).

3.5. Consultation findings

All of the consulted stakeholders accorded with the review’s findings regarding the low adequate PA prevalence among AIR. They attributed the lower adequate PA prevalence among AIR in North America relative to Europe to differences in pedestrian/cyclist infrastructure, transportation networks and weather conditions. One consultant explained that pedestrian/cyclist infrastructure is more well-maintained in Europe than North America, encouraging individuals to participate in leisure and transport walking/cycling. The same consultant further added that the better transportation system in Europe relative to North America helps AIR, particularly those who have no private vehicles, join/attend PA programs easily. All of the consultants advised that AIR usually exhibit low attendance at exercise classes/sessions, despite having positive attitudes and being knowledgeable about PA recommendations. They attributed the lower LTPA prevalence among AIR women compared to men to several factors including, lack of appropriate clothing, cultural stigma around Arab women’s PA participation, family responsibility, and street harassment due to hijab. One consultant exemplified that many AIR women in the UK and Ireland report exposure to sexual harassments in mixed-gender swimming pools when wearing a hijabi burkini. These negative experiences made many AIR women feel reluctant to participate anymore in PA.

The consultants supported the barriers to AIR’s PA participation revealed in this review. They explained that most AIR lack PA skills/literacy, particularly in the leisure domain. Two consultants added that many AIR, particularly older adults, lack interest in PA participation and only feel motivated to participate in groups as an opportunity for socialization. They also clarified that LTPA type can be a significant motive, where many AIR show higher attendance in swimming classes than other sessions (e.g., yoga). The consultants illustrated that cultural restrictions substantially hinder AIR’s PA participation. One consultant, moreover, advised that the inaccessibility of urban farms in Ireland represent a major barrier to occupational PA participation among AIR who used to rely on farming/gardening as an essential way to stay physically active and achieve a state of food security.

The facilitators of PA participation revealed in this study, were also supported by all of the consultants. They emphasized the need for both male and female Arab trainers/coaches, who are proficient in the Arabic language, in fitness centers to provide PA education/training to AIR, improving their confidence and PA literacy/skills. One consultant suggested the provision of PA assistance fund, exemplifying that the City of Mississauga, Ontario, Canada, offers credit to each member of low-income families for recreational activities, which enhances AIR’s PA participation. The consultants advised that the provision of separate gender fitness sessions would enhance AIR’s PA participation. One consultant recommended that allocating specific timings for all women would help increase AIR and other concerned minority groups’ PA participation, while also improving social inclusion. The consultants advised that enhancing the production/supply of affordable hijab sportswear in clothing stores in Western countries would improve AIR women’s PA participation. They also highlighted the need for more social/community support, particularly for AIR women, increasing their confidence in PA participation. The consultants advised that improving cyclist/pedestrian infrastructure, particularly in North America, would enhance AIR and the broader populations’ PA participation. The consultants’ input contributed to developing sensible recommendations for
future research and policy/practice. This would help public health professionals and policy makers develop tailored PA-promoting programs and policies, enhancing AIR’s PA participation.

4. Discussions

This scoping review explored PA prevalence and influences affecting AIR’s PA participation to direct future PA research/programs and inform requisite policy change towards developing PA-friendly environments. Most eligible studies adopted either qualitative or cross-sectional design (90%), underscoring a gap in mixed-method and longitudinal/analytical research. The US and Europe are considerably ahead of Canada and Australia in AIR-PA research.

Our study highlights the low prevalence of adequate PA across domains among AIR in Western countries. Although AIR reported sound knowledge of PA recommendations, their PA participation was below the recommended levels, revealing a knowledge-compliance gap. The prevalence of AIR’s participation in adequate total PA was higher in Europe than the US (26–49% vs. 11–22%, respectively). These notable differences in PA levels can be in part attributed to the unsafe/poorly maintained pedestrian/cycling infrastructure in the US compared to Europe (Pucher and Buehler, 2016). In 2010, cyclists had pedestrian fatalities per 100 million cycled/walked kilometers were significantly higher in the US than Germany (4.7 and 9.7 vs. 1.3 and 1.9, respectively) (Buehler and Pucher, 2016). Our review showed that the prevalence of adequate PA among AIR was even lower when assessed objectively (11–17% in Europe), indicating potential bias in self-reported data (Sylvia et al., 2013). We believe that the objectively measured PA data are more reliable than the self-reported figures, although most PA measurement devices have some limitations to consider (e.g., primarily measuring locomotor activity) (Lee and Shiroma, 2014). Combination of both self-reported and objective measures is the most recommended way to improve data reliability. The review produced limited domain-specific PA prevalence data, and those particularly focused on LTPA in Europe. AIR women reported the lowest prevalence of sufficient LTPA (25–32%). Arab women usually experience more cultural/religious restrictions to LTPA participation than men (Guerin et al., 2003).

Furthermore, the common exclusive housekeeper role among AIR limits their ability to engage in leisure exercises.

Our study showed that positive attitudes towards PA were not enough to increase AIR’s PA levels. The study revealed numerous barriers and facilitators that need to be addressed to enhance AIR’s PA participation. Mainstream language illiteracy and limited PA skills were common personal barriers to LTPA and TPA among AIR. Similar findings were found among other ethnic immigrants in Europe and North America (Langoen et al., 2017). Inability to communicate in the mainstream language reduces immigrants’ accessibility to PA-related information, including techniques and places to exercise (Horne et al., 2012). Linguistically sensitive PA programs enhanced AIR’s LTPA and TPA participation. Poverty was a major socioeconomic barrier to AIR’s LTPA participation. Similar findings were reported among other multi-ethnic immigrants in the Netherlands (de Munter et al., 2012). Financial restraints are a common immigration stressor that limit immigrants’ ability to pay for gyms/fitness centres memberships or purchase sportswear/equipment.

Family responsibility was a key psychosocial barrier to LTPA and TPA participation among AIR women. Across many cultures, women hold substantial responsibility for housekeeping and childcare. This role, however, often becomes more demanding following immigration due to various migration stressors (e.g., language issues) (Kalavar et al., 2005). Social support and community cohesion helped address the family commitment issues among AIR women, enhancing their PA participation beyond the domestic domain. Cultural restrictions hindered AIR women’s LTPA participation. This barrier was also cited among other non-Arab Muslim immigrant women (Pakistan) in Europe (Horne et al., 2012). Practising Muslim women share the same cultural/religious prohibitions that restrict them from wearing tight/short sports clothing in public and require them to wear hijab, minimizing their PA levels (Nakamura, 2002). Provision of culturally tailored PA programs/resources (e.g., women-only hours) helped tackle the cultural restriction barrier, enabling AIR to increase their exercise levels.

Poorly maintained pedestrian/cyclist infrastructure was a key environmental barrier to leisure and transport walking/cycling among AIR in North America, but not Europe. Indeed, these are also common barriers to PA among general populations in North America (Salvo et al., 2018). Nine of the top ten cities in the 2019 Bicycle Cities Index (assessed based on different criteria, including presence of quality infrastructure) were European ones, with Hangzhou (China) being the only non-European city, ranking seventh on this list (Richter, 2019). Lack of safety from crime/traffic reduced AIR’s participation in TPA and leisure walking/cycling. Similar findings were noted among other immigrant subgroups and the wider population across Western countries (Jongeneel-Grimen et al., 2014; Langoen et al., 2017). Inaccessibility of farms was a key environmental barrier to occupational PA among AIR. Many Arabs consider farming/gardening not only a key source of income, but also a considerable way for being physically active, food secure and psychologically well (Wieland et al., 2015). Overreliance on labor-saving equipment and living in non-spacious apartments/houses limited AIR women’s domestic PA. Many AIR previously lived in vast houses in their home countries with no/limited access to labor-saving technology, which required them to be physically active at home (Nicolao et al., 2012). Given that labor-saving household appliances have become an integral part of the Western lifestyle, technology barriers may be challenging to address (Liu, 2019). Therefore, intense effort should be focused on addressing the more manageable barriers, such as the limited PA skills and limited availability of hijab sportswear, to increase AIR’s participation in other domain-specific PA types.

5. Strengths and limitations

This scoping review addressed PA participation across domains among AIR in Western countries, which has thus far been limitedly researched. Since there are no gold standards for database selection in the conduct of scoping reviews and given the focus of our research topic, we systematically searched five databases of health and social sciences. A stakeholder consultation was implemented to validate the study’s findings. Only English records were eligible, which may have led to excluding potential non-English European papers. The quality of the eligible studies was not examined to include a substantial range of peer-reviewed and grey literature evidence and study designs. Over half of the studies that assessed PA prevalence used self-reported questionnaires, making our findings subject to recall and/or social desirability bias (Elshahat et al., 2020).

6. Conclusions and future directions

AIR-PA research in Western countries is limited, with Canada and Australia far behind Europe and the US. Most evidence in this area comes from qualitative and cross-sectional studies, indicating a gap in longitudinal and mixed-method research. Despite having positive attitudes and sound knowledge of PA recommendations, AIR showed low adequate PA prevalence across life domains, revealing a knowledge-compliance gap. Distinct barriers to PA included cultural restrictions, discrimination, limited PA skills and family responsibility, whereas improved PA literacy, social support, culturally sensitive programs and increased safety measures were powerful facilitators.

We propose the conduct of community-engaged, mixed-method research to examine PA prevalence and factors affecting AIR’s PA participation across life domains. Nationwide longitudinal research, with sub-group analyses (e.g., age, gender, religion, socioeconomic status) is also recommended to trustworthy identify PA determinants. For the assessment of PA, we suggest the use of both validated self-
reported and objective measures to improve data reliability. We also recommend the development of evidence-based, culturally sensitive PA-promoting interventions addressing the to-be-explored factors hindering AIR’s PA participation. Feasibility studies and evaluation research should be implemented for any interventions before scaling up.

This review recommends actions for consideration by ministries, government agencies and non-governmental institutions to enhance AIR and other vulnerable populations’ PA participation. Recommendations include providing assistance fund devoted to recreational activities among low-income families, and developing linguistically appropriate, PA-oriented databases to help raise AIR’s awareness/navigation of the available resources. Providing employment opportunities for Arab trainers in fitness facilities can facilitate effective communication, improving AIR’s PA skills/literacy. Incentivizing sport clothing industry/companies to produce hijab sportswear and encouraging fitness facilities to provide “all women-only hours” can enhance any concerned women’s PA participation. Enhancing opportunities for community/urban farming can help AIR increase their PA levels. Finally, investing in pedestrian/cyclist-friendly infrastructure can increase all populations’ PA participation, including AIR.

**Declaration of Competing Interest**

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

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**Appendix A. The search terms operated in the automated databases**

| Concept 1 | "physic* active" OR PA OR exercise* OR exert* OR "physic* fit" OR cycl* OR hik* OR ORL* OR stretch* OR walk* OR jog* OR run* OR LTPA OR TPA OR DPA OR OPA OR "leisure-time physical activit*" OR "travel physical activit*" OR "domestic physical activit*" OR "occupational physical activit*" OR "swim* OR garden* OR "weight lift" OR "strength train" OR strength* OR yoga OR "resistance train" OR "circuit weight train" OR "aerobic train" OR sport* |

| Concept 2 | "Middle East" OR "North Africa" OR Arabia* OR Arab* OR "Arabic OR Syria* OR Pal* OR Yemen* OR Somal* OR Egypt* OR Leban* OR Iraq* OR Jordan* OR Sudan* OR Oman* OR Liby* OR Tunisia* OR Algeria* OR Morocco* OR Kuwait* Saudi Arabia* OR KSA OR Bahrain* OR Qatar* "United Arab Emirates" OR UAE OR Maurit* OR Djibout* OR Comor* |

| Concept 3 | immigrant* OR migrant* OR refugee* OR asylum* OR immigration* OR migration* OR newcomers* OR OR OR OR OR OR OR |

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**Appendix B. Characteristics of the included studies**

*Figures are not additive because some studies examined more than one PA domain. Abbreviations: AIR: Arab immigrants and refugees; DPA: domestic physical activity; LTPA: leisure-time physical activity; OPA: occupational physical activity; PA: physical activity; TPA: travel physical activity; RCT: randomized controlled trail.

| Study category | Number of studies n (%) |
|----------------|-------------------------|
| **Country of authorship** |           |
| US             | 33 (44%)                |
| Sweden         | 13 (18%)                |
| Australia      | 10 (13%)                |
| Netherlands    | 5 (7%)                  |
| UK             | 5 (7%)                  |
| Canada         | 4 (5%)                  |
| Norway         | 2 (3%)                  |
| New Zealand    | 1 (1%)                  |
| France         | 1 (1%)                  |
| Mixed different Western countries | 1 (1%) |
| **Native country of AIR** |                        |
| Mixed different Arabic countries | 30 (41%) |
| Somalia        | 21 (28%)                |
| Iraq           | 9 (12%)                 |
| Sudan          | 5 (7%)                  |
| Morocco        | 5 (7%)                  |
| Lebanon        | 3 (4%)                  |
| Tunisia        | 1 (1%)                  |
| **Study Design** |                       |
| Cross-sectional survey | 27 (37%) |
| Focus group study | 23 (31%) |
| Qualitative interviews | 9 (12%) |
| Focus group & interviews | 7 (9%) |
| Mixed method study | 4 (5%) |

(continued on next page)
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