



Review

Barriers to lifestyle modification in patients with non-alcoholic fatty liver disease: a scoping review

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Abstract

Objective: Non-alcoholic fatty liver disease is common worldwide, and lifestyle modifications are key to its treatment. This study aimed to identify the barriers to lifestyle modifications in patients with non-alcoholic fatty liver disease and to organize the results using the Capability Opportunity Motivation-Behavior (COM-B) model.

Materials and Methods: The framework of Arksey and O' Malley was used in this scoping review. We searched PubMed, Scopus, and the Cochrane Library without language restrictions for reports published up to September 11, 2022, including peer-reviewed literature reporting barriers to lifestyle modifications in patients with non-alcoholic fatty liver disease. Patient-reported barriers were analyzed inductively and organized into the components (capability, opportunity, and motivation) of the COM-B model.

Results: The literature search yielded 583 articles, of which seven qualitative studies, four quantitative studies, and one mixed-methods study met the inclusion criteria. Lack of time, lack of information on the diagnosis and management of non-alcoholic fatty liver disease, negative perceptions of the prescribed exercise and diet, physical symptoms interfering with the behavior, presence of comorbidities, and lack of family cooperation were frequently reported as barriers.

Conclusion: The results of this study may contribute to the development of appropriate care and education strategies to promote behavioral changes in patients with non-alcoholic fatty liver disease.

Key words: non-alcoholic fatty liver disease, lifestyle, barriers, Capability Opportunity Motivation-Behavior (COM-B) model

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Introduction

The global prevalence of non-alcoholic fatty liver disease (NAFLD) is approximately 30%, and the number is increasing rapidly¹. NAFLD is a liver disease associated with obesity, insulin resistance, type 2 diabetes, hypertension, hyperlipidemia, and metabolic syndrome², with an increased risk of cardiovascular events³ and hepatocellular

carcinoma⁴. Lifestyle modifications, including diet and exercise, are key to its management^{5, 6} because there is currently no pharmacological therapy for NAFLD.

Diet and exercise for weight loss are the most effective lifestyle modification strategies for patients with NAFLD⁷, and growing evidence shows these strategies' efficacy^{8, 9}. Furthermore, several guidelines recommend lifestyle modifications in diet and exercise^{6, 10}. However, adopting and maintaining an appropriate lifestyle remains challenging for various reasons¹¹, and weight loss remains difficult despite intensive and multidisciplinary lifestyle interventions¹². Therefore, identifying the barriers to lifestyle modifications in patients with NAFLD is crucial for developing efficient and effective interventions.

A previous narrative review has identified barriers to implementing lifestyle changes in patients with NAFLD¹³; however, a comprehensive and exploratory literature search was not performed. Furthermore, an analysis of behavior change based on behavioral science, which provides an

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evidence-based understanding of human behavior, has not yet been completed. The Behavior Change Wheel (BCW) is a framework used for designing and implementing interventions to promote behavior change, the core of which is the Capability Opportunity Motivation-Behavior (COM-B) model. This is the starting point for developing interventions and a model to understand human behavior¹⁴. Based on the COM-B model, behavior is attributed to capability, opportunity, and motivation individually and interactively. These factors directly affect behavior; however, capability and opportunity indirectly affect behavior by influencing motivation. Capability consists of “psychological” and “physical” domains and refers to the capacity (including knowledge and skills) to perform a behavior. Opportunity consists of “physical” and “social” domains and refers to all factors external to the individual that encourage or enable behavior. Motivation consists of “reflective” and “automatic” domains and refers to all brain processes that activate and direct behavior¹⁵. Therefore, the COM-B model, which is useful for understanding barriers to behavior, has been used in several studies to identify barriers to various health behaviors^{16, 17}. Furthermore, organizing barriers using the COM-B model can contribute to developing BCW-based interventions.

Therefore, this scoping review aimed to identify the barriers to lifestyle modifications in patients with NAFLD and organize the results using the COM-B model.

Materials and Methods

This scoping review was conducted to summarize the published literature on barriers to lifestyle modifications in patients with NAFLD. We used the five-stage framework proposed by Arksey and O'Malley¹⁸, and the results were reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Review¹⁹.

Research question and search strategy

The research question for this study was “What is known from the literature about barriers to lifestyle modifications in patients with NAFLD?”. As indicated by the current guidelines, lifestyle modifications include exercise, diet, and weight loss¹⁰. Literature searches were conducted in PubMed, Scopus, and the Cochrane Library without language restrictions from inception to September 11, 2022. The reference lists of all the included studies were manually searched. The primary search terms used were “non-alcoholic fatty liver disease” AND (“life style” OR “exercise” OR “physical activity” OR “diet” OR “weight loss”) AND (“barrier*” OR “obstacle*” OR “hindrance*”); the complete search strategy is presented in Figure 1. The identified studies were exported to an EndNote20 library, and duplicates were extracted and removed before screening for eligibility.

Study selection and charting of the data

All titles and abstracts were independently screened by two authors according to relevance and inclusion criteria. Full texts were independently assessed by two authors to confirm eligibility. Any disagreements between authors were resolved through discussion. We included studies conducted among adult patients (aged ≥ 18 years) diagnosed with NAFLD who reported different barriers to lifestyle modifications. Peer-reviewed scientific articles, including qualitative, quantitative, and mixed-methods studies, were included, whereas case reports, editorials, commentaries, and review articles were excluded.

Data were entered into an Excel chart based on the content proposed by Arksey and O'Malley¹⁸. This chart included the author, title, year of publication, country, sample size, mean age, sex, body mass index (BMI), purpose of the study, methodology, and findings regarding barriers. The barriers reported in the included studies were extracted using different methods used in the qualitative and quantitative studies. For qualitative studies, we extracted data on themes, subthemes, or codes describing patient-reported barriers (if not specified as barriers, the context describing the factors that make it difficult to modify lifestyle behaviors). For the quantitative studies, we extracted data on the items reported as barriers to which at least 30% of the participants agreed. Data were extracted by the first author and reviewed by the second author to confirm that the data were extracted according to the study aims. Disagreements and uncertainties were discussed, and a consensus was reached.

Charting, summarizing, and reporting the results

First, the included studies were summarized using descriptive methods to identify the quantities and ranges. Second, new themes were attached to the data on barriers and classified based on differences and similarities. These themes were applied to the following components of the COM-B model: capability (psychological and physical), opportunity (physical and social), and motivation (reflective and automatic). If the meaning of the content related to the themes, subthemes, and codes was unclear, the content was evaluated by reviewing illustrative quotations. The processes were performed by the first author and verified by the second author. When necessary, advice from a third author, who is an expert in qualitative research, was sought and implemented. Other authors reviewed the content, and disagreements were resolved through repeated discussions and rereading of the articles, leading to the final classification.

Results

Study selection

The literature search identified 583 articles. After re-

Database name	Search strategy	Number of hits
PubMed	<p>(((((("Non-alcoholic fatty liver disease"[MeSH Terms]) OR ("non-alcoholic fatty liver disease"[title/abstract]) OR ("nonalcoholic fatty liver disease"[title/abstract]) OR ("NAFLD"[title/abstract])))</p> <p>AND</p> <p>(((((("Life style"[MeSH terms]) OR ("life style"[title/abstract]) OR ("life styles" [title/abstract]) OR (lifestyle*[title/abstract]) OR ((((((("exercise"[MeSH terms]) OR ("exercise therapy"[MeSH terms]) OR (exercise*[title/abstract]) OR ("physical activity"[title/abstract]) OR ("physical activities"[title/abstract]) OR ("exercise therapy"[title/abstract]) OR ("exercise therapies"[title/abstract])) OR ((((((("diet"[MeSH terms]) OR ("diet therapy"[MeSH terms]) OR ("feeding behavior"[MeSH terms]) OR (diet*[title/abstract]) OR ("diet therapy"[title/abstract]) OR ("diet therapies"[title/abstract]) OR ("feeding behavior"[title/abstract]) OR ("feeding behaviors"[title/abstract])) OR ((("weight loss"[MeSH terms]) OR ("weight loss"[title/abstract])))</p> <p>AND</p> <p>((Barrier*[title/abstract]) OR (obstacle*[title/abstract]) OR (hindrance*[title/abstract]))</p>	268
Scopus	<p>(((TITLE-ABS-KEY ("non-alcoholic fatty liver disease") OR TITLE-ABS-KEY ("non-alcoholic fatty liver disease") OR TITLE-ABS-KEY ("NAFLD")))</p> <p>AND</p> <p>(((TITLE-ABS-KEY ("life style") OR TITLE-ABS-KEY (lifestyle))) OR ((TITLE-ABS-KEY (exercise) OR TITLE-ABS-KEY ("physical activity") OR TITLE-ABS-KEY ("exercise therapy")) OR ((TITLE-ABS-KEY (diet) OR TITLE-ABS-KEY ("diet therapy") OR TITLE-ABS-KEY ("feeding behavior"))) OR (TITLE-ABS-KEY ("weight loss")))</p> <p>AND</p> <p>(((TITLE-ABS-KEY (barrier) OR TITLE-ABS-KEY (obstacle) OR TITLE-ABS-KEY (hindrance))))</p>	303
Cochrane Library	<p>#1 MeSH descriptor: [non-alcoholic fatty liver disease] explode all trees</p> <p>#2 ("Non-alcoholic fatty liver disease"):ti,ab,kw #3 ("nonalcoholic fatty liver disease"):ti,ab,kw #4 (NAFLD):ti,ab,kw</p> <p>#5 #1 OR #2 OR #3 OR #4</p> <p>#6 MeSH descriptor: [life style] explode all trees #7 ("life style"):ti,ab,kw #8 ("life style"):ti,ab,kw</p> <p>#9 (Lifestyle):ti,ab,kw (Word variations have been searched)</p> <p>#10 #6 OR #7 OR #8 OR #9</p> <p>#11 MeSH descriptor: [exercise] explode all trees #12 MeSH descriptor: [exercise therapy] explode all trees</p> <p>#13 (Exercise):ti,ab,kw (Word variations have been searched) #14 ("physical activity"):ti,ab,kw</p> <p>#15 ("physical activities"):ti,ab,kw #16 ("exercise therapy"):ti,ab,kw #17 ("exercise therapies"):ti,ab,kw</p> <p>#18 #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17</p> <p>#19 MeSH descriptor: [diet] explode all trees #20 MeSH descriptor: [Diet Therapy] explode all trees</p> <p>#21 MeSH descriptor: [feeding behavior] explode all trees #22 (diet):ti,ab,kw (Word variations have been searched)</p> <p>#23 ("Diet therapy"):ti,ab,kw #24 ("diet therapies"):ti,ab,kw #25 ("feeding behavior"):ti,ab,kw</p> <p>#26 ("Feeding Behaviors"):ti,ab,kw</p> <p>#27 #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26</p> <p>#28 MeSH descriptor: [weight loss] explode all trees #29 ("weight loss"):ti,ab,kw</p> <p>#30 #28 OR #29</p> <p>#31 (barrier):ti,ab,kw (Word variations have been searched) #32 (obstacle):ti,ab,kw (Word variations have been searched)</p> <p>#33 (hindrance):ti,ab,kw (Word variations have been searched)</p> <p>#34 #31 OR #32 OR #33</p> <p>#35 #10 OR #18 OR #27 OR #30</p> <p>#36 #5 AND #35 AND #34</p>	12

Figure 1 Search strategies.

moving duplicates, the titles and abstracts of 335 articles were screened. Of these, 323 articles did not meet the inclusion criteria and were excluded. The full texts of the remaining 12 articles were screened, and two articles that did not mention the barriers were excluded. In addition, the refer-

ence lists of all included studies were manually searched, and two additional articles were identified, of which 12 were included in this review. The study selection process is shown in Figure 2.

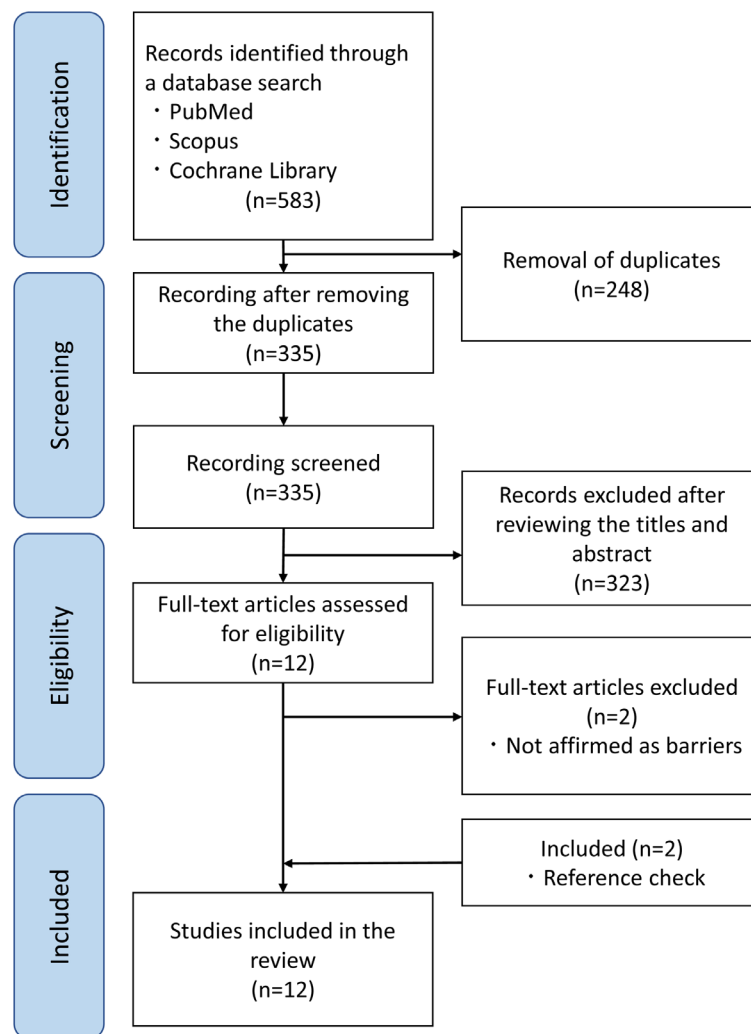


Figure 2 Flowchart of the study selection process.

Study characteristics

All 12 included studies were published after 2017 and were written in English^{20–31}). Among the included studies, seven used qualitative methods^{20–22, 25, 27, 29, 31}), four used quantitative methods^{23, 26, 28, 30}), and one used mixed methods²⁴). Four studies were published in the United Kingdom^{21, 24, 25, 29}), four in the United States^{23, 26, 30, 31}), and one each in Australia²²), India²⁰), South Korea²⁷), and Ireland²⁸). The number of patients with NAFLD ranged from 12 to 414^{20–31}). Nine studies reported the mean age, which ranged from 41.1 to 58.9 years^{20, 22–27, 29, 30}). Another study reported a median age of 54.0 years²⁸), and one reported 15 of 29 participants were aged >50 years³¹). Ten studies reported the sex of the study population, with female participants accounting for 33.3–63.2%^{20, 22–25, 27–31}). Four studies reported the mean BMI (range: 34.3–40.0 kg/m²)^{23, 24, 29, 30}). Another study reported a BMI range of 25.0–39.9 kg/m²²⁰), whereas one study reported a BMI of ≥ 30 kg/m² in 75.6% of participants²⁶). Table

1 summarizes the included studies.

Barriers to lifestyle modification

The barriers extracted from the included studies were assigned new themes and categorized according to the COM-B components (capability, opportunity, and motivation) (Table 2). The following section describes the results based on COM-B components.

Capability

“Psychological capability” was reported in three studies^{24, 27, 28}). Of these, two reported a lack of knowledge about NAFLD^{24, 27}), whereas one reported a lack of willpower²⁸). “Physical capability” was reported in seven studies^{20, 23, 24, 26, 28, 30, 31}). Of these, three reported physical symptoms interfering with the behavior, such as fatigue, shortness of breath, discomfort, and pain^{20, 23, 26}) and presence of comorbidities^{20, 23, 31}), followed by poor health and

Table 1 Summary of the included studies

Author Year of publication	Title	Country	Sample size	Mean age (years)	Sex female %	BMI kg/m ²	Study aim	Methodology
Arora, C., <i>et al.</i> 2021 ²⁰⁾	Perceived barriers and facilitators for adherence to lifestyle prescription: Perspective of obese patients with non-alcoholic fatty liver disease from north India	North of India	30	41.1 ± 11.2	40	range 25.0–39.9	To identify the barriers and facilitators faced by obese patients with NAFLD undergoing lifestyle modification	Qualitative
Avery, L., <i>et al.</i> 2017 ²¹⁾	Lifestyle behavior change in patients with non-alcoholic fatty liver disease: a qualitative study of clinical practice	United Kingdom	12	Not reported	Not reported	Not reported	To identify the current status and improvements in lifestyle behavior change support for patients with NAFLD from the perspectives of both healthcare providers and patients	Qualitative
George, E. S., <i>et al.</i> 2022 ²²⁾	A Mediterranean and low-fat dietary intervention in non-alcoholic fatty liver disease patients: exploring participant experience and perceptions about dietary change	Australia	23	49.6 ± 15.9	52.2	Not reported	To explore the acceptability by understanding the barriers and enablers of the MD and low-fat diet interventions as perceived by the participating Australian adults from multicultural backgrounds with NAFLD	Qualitative
Glass, O., <i>et al.</i> 2022 ²³⁾	Perceptions of exercise and its challenges in patients with non-alcoholic fatty liver disease: a survey-based study	United States	94	58.0 ± 11.0	42.6	mean 34.3 ± 5.2	To assess the baseline physical activity and sedentary behavior, self-perceived fitness, limitations to exercise, potential solutions to increase physical activity, and perception of exercise as a foundational treatment for NAFLD	Quantitative
Haigh, L., <i>et al.</i> 2019 ²⁴⁾	Barriers and facilitators to the Mediterranean diet adoption by patients with non-alcoholic fatty liver disease in Northern Europe	Northern United Kingdom	19	58.5 ± 10.6	63.2	mean 36.2 ± 6.3	To determine the key barriers and facilitators to the adoption and maintenance of Mediterranean diet intervention in the northern European population	Mixed methods
Hallsworth, K., <i>et al.</i> 2020 ²⁵⁾	Using the theoretical domains framework to identify barriers and enabling factors to implementation of guidelines for the diagnosis and management of non-alcoholic fatty liver disease: a qualitative study	United Kingdom	12	58.9	33.3	Not reported	To identify the barriers and enabling factors to the implementation of guidelines for the diagnosis and management of NAFLD	Qualitative
Heredia, N. I., <i>et al.</i> 2022 ²⁶⁾	Perceived barriers to weight loss among Hispanic patients with non-alcoholic fatty liver disease	United States	414	45.6 ± 11.2	Not reported	≥30 75.6%	To identify the barriers that hinder Hispanic patients with NAFLD from modifying their PA and dietary behaviors	Quantitative
Jang, Y., <i>et al.</i> 2021 ²⁷⁾	A qualitative study of self-management experiences in people with non-alcoholic fatty liver disease	South Korea	12	53.8 ± 15.1	58.3	Not reported	To explore the experience of self-management in patients with NAFLD	Qualitative
O’Gorman, P., <i>et al.</i> 2021 ²⁸⁾	Determinants of physical activity engagement in patients with non-alcoholic fatty liver disease: the need for an individualized approach to lifestyle interventions	Ireland	101	median 54.0 ± 15.0	47.5	Not reported	To determine (1) the awareness of and adherence to the WHO PA guidelines, (2) the barriers and motivators to engaging in PA, and (3) how PA determinants, awareness of the PA guidelines, and demographic characteristics influence PA participation in patients with NAFLD	Quantitative
Seragg, J., <i>et al.</i> 2021 ²⁹⁾	Factors associated with engagement and adherence to a low-energy diet to promote 10% weight loss in patients with clinically significant non-alcoholic fatty liver disease	United Kingdom	23	56.0 ± 11.0	34.8	mean 40.0 ± 7.0	To identify the factors associated with uptake, engagement, and adherence to LED interventions To identify the mediating factors, both barriers and facilitators, related to adherence	Qualitative
Stine, J. G., <i>et al.</i> 2021 ³⁰⁾	Breaking down barriers to physical activity in patients with non-alcoholic fatty liver disease	United States	87	52.3 ± 12.9	60	mean 34.5 ± 6.6	To determine the perceived barriers to physical activity and enablers to exercise intervention in patients with NAFLD	Quantitative
Tincopa, M. A., <i>et al.</i> 2021 ³¹⁾	Patient disease knowledge, attitudes and behaviors related to non-alcoholic fatty liver disease: a qualitative study	United States	29	15 were ≥50	51.7	Not reported	To assess the disease perspectives and report the barriers and facilitators to the management of their disease through semi-structured qualitative interviews among persons with NAFLD	Qualitative

BMI: body mass index; NAFLD: non-alcoholic fatty liver disease

Table 2 Barriers to lifestyle modification in patients with NAFLD

COM-B component	Barriers	References
Psychological capability	Lack of knowledge about NAFLD	24, 27)
	Lack of willpower	28)
Physical capability	Physical symptoms interfering with the behavior (e.g., fatigue, shortness of breath, discomfort, and pain)	20, 23, 26)
	Presence of comorbidities	20, 23, 31)
	Poor health and physical function	23, 24)
	Lack of energy	23, 28)
	Physical symptoms caused by exercise	30)
Physical opportunity	Lack of time	22, 23, 26, 28, 30, 31)
	Lack of financial resources	20, 26)
	Lack of spaces for exercises	20)
Social opportunity	Medical-related	
	Lack of information from HCPs about the management of NAFLD	21, 25, 27, 30)
	Lack of information from HCPs about the diagnosis of NAFLD	21, 25, 31)
	Unhelpful telephone intervention	24)
	Unhelpful standardized approaches	24)
	Information overload	27)
	Family-based	
	Lack of family cooperation	20, 24, 31)
	Multiple responsibilities within a family	20, 31)
	Work- and community-based	
	Unrefusable meals in social situations	20, 24)
	Social and cultural influences	24, 31)
Workplaces with sedentary and difficult-to-manage diets	20, 24)	
Inflexible work schedules	20, 29)	
Reflective motivation	Negative perception of the prescribed exercise	20, 26, 30)
	Negative perception of the prescribed diet	20, 22)
	Low concern about NAFLD	20, 31)
	Values for lifestyle change	31)
	Low awareness of nutrition	24)
	Perception that efforts are ineffective	20)
Automatic motivation	Life stressors	20, 24)
	Low intrinsic motivation	23, 24)
	Perceive NAFLD as ambiguous	24, 31)
	Perceive the diagnosis of NAFLD as unexpected	25, 31)
	Mismatched food preferences	24, 26)
	Psychological fulfillment obtained only through food	22, 24)
	Helplessness	24)
	Attitudinal ambivalence	24)
	Low level of acceptance	24)
	Difficulty in breaking old habits	20)
	Lack of physical symptoms related to NAFLD	31)
	Excessive demand for food skills	24)
	Hunger craving	20)

NAFLD: non-alcoholic fatty liver disease; COM-B: capability opportunity motivation-behavior; HCPs: healthcare professionals.

physical function^{23, 24)}, lack of energy^{23, 28)}, and physical symptoms caused by exercise³⁰⁾.

Opportunity

“Physical opportunity” was reported in seven studies^{20, 22, 23, 26, 28, 30, 31)}. Of these, six reported a lack of

time^{22, 23, 26, 28, 30, 31)}, followed by a lack of financial resources^{20, 26)} and spaces for exercise²⁰⁾. “Social opportunity” was reported in eight studies^{20, 21, 24, 25, 27, 29–31)}, six of which were medical-related^{21, 24, 25, 27, 30, 31)}, three were family-based^{20, 24, 31)}, and four were work- and community-based^{20, 24, 29, 31)}. Among the medical-related studies, four reported a lack of infor-

mation from healthcare professionals (HCPs) about the management of NAFLD^{21, 25, 27, 30}), whereas three reported a lack of information from HCPs about the diagnosis of NAFLD^{21, 25, 31}), followed by unhelpful telephone intervention²⁴), standardized approaches²⁴), and information overload²⁷). Of the family-based studies, three reported a lack of family cooperation^{20, 24, 31}), whereas two reported multiple responsibilities within a family^{20, 31}). Among work- and community-based studies, two reported unrefusable meals in social situations^{20, 24}), social and cultural influences^{24, 31}), workplaces with sedentary and difficult-to-manage diets^{20, 24}), and inflexible work schedules^{20, 29}).

Motivation

“Reflective motivation” was reported in six studies^{20, 22, 24, 26, 30, 31}). Of these, three reported negative perception of the prescribed exercise^{20, 26, 30}), followed by negative perception of the prescribed diet^{20, 22}), low concern about NAFLD^{20, 31}), values for lifestyle change³¹), low awareness of nutrition²⁴), and a perception that efforts are ineffective²⁰). “Automatic motivation” was reported in seven studies^{20, 22–26, 31}). Life stressors,^{20, 24} low intrinsic motivation^{23, 24}), perceive NAFLD as ambiguous^{24, 31}), perceive the diagnosis of NAFLD as unexpected^{25, 31}), mismatched food preferences^{24, 26}), and psychological fulfillment obtained only through food^{22, 24}) were each reported in two studies. Helplessness²⁴), attitudinal ambivalence²⁴), low levels of acceptance²⁴), difficulty in breaking old habits²⁰), lack of physical symptoms related to NAFLD³¹), excessive demand for food skills²⁴), and hunger craving²⁰) were reported in each study.

Discussion

This is the first review to analyze the barriers to lifestyle modifications in patients with NAFLD using the COM-B model. All barriers identified in this study could be organized and explained based on the three components of the COM-B model. Ranking the importance of all identified barriers is impossible; however, we aimed to explain each based on the definitions of barriers reported in several studies. The barriers to “psychological capability” included a lack of knowledge about NAFLD and a lack of willpower, whereas those to “physical capability” were mainly physical symptoms interfering with the behavior and the presence of comorbidities. Regarding the opportunity domain, the main barriers to “physical opportunity” included lack of time and financial resources, whereas “social opportunity” included lack of information from HCPs and lack of family cooperation. Regarding the motivation domain, the barriers to “reflective motivation” were mainly low concern about NAFLD and negative perceptions of the prescribed diet and exercise, whereas those to “automatic motivation” were life stressors, low intrinsic motivation, ambiguous or unexpect-

ed perceptions of NAFLD, mismatched food preferences, and psychological fulfillment obtained only through food.

Understanding the complexity of the multiple barriers identified in the present study is necessary for lifestyle modifications in patients with NAFLD because behavior is generated by capability, opportunity, and motivation¹⁵). Motivation support is important in generating behavior^{32, 33}); however, the capability and opportunity available to HCPs and society to intervene are more important because they directly or indirectly affect behavior through motivation. Because many studies have reported the lack of information provided by HCPs^{21, 25, 27, 30, 31}) and patients are often unable to access adequate information due to information overload²⁷), providing adequate information obtained from the HCPs can directly or indirectly contribute to lifestyle modifications. Therefore, HCPs, including nurses, should be involved, although explanations by physicians are essential. Nurses have played an essential role in the management of hepatitis and other liver diseases^{34, 35}), and their effective involvement in the management of NAFLD has been reported³⁶). According to a study conducted in Japan, hepatitis medical care coordinators, who have been part of various healthcare organizations and are educated to provide seamless support to patients with hepatitis³⁷), can play a similar role for patients with NAFLD.

The mean age of patients with NAFLD worldwide was 47.3 years¹), whereas that of our study participants was 40–50 years old. Age-related barriers included multiple responsibilities within a family^{20, 31}), workplaces with sedentary and difficult-to-manage diets^{20, 24}), and unrefusable meals in social situations^{20, 24}). Lifestyle is difficult to change because it is associated with various daily activities and requires support from family, workplace, and society^{38, 39}). Therefore, NAFLD should be recognized as a societal problem, and the importance of lifestyle modifications in treating NAFLD should be made known to all.

In recent years, qualitative studies have examined barriers to weight management in patients with NAFLD using the COM-B model⁴⁰); the results, such as reactions to hunger, lack of awareness of NAFLD, and lack of time and energy, were consistent with those of the present study. However, the present study revealed differences in other results, such as physical symptoms interfering with the behavior, negative perceptions of the prescribed exercise and diet, life stressors, and inflexible work schedules. This can be attributed to the comprehensiveness of the findings obtained, as the present study systematically collected many quantitative, qualitative, and mixed-methods studies and expanded the regions covered and the number of participants. No previous studies have comprehensively and exploratively searched for barriers to lifestyle modifications in patients with NAFLD. The present study used the components of the COM-B model to organize the barriers, making it easier to identify problems

and obtain a comprehensive picture of patients with NAFLD. As part of the framework for behavior change interventions, the COM-B model can be used at various levels, including the individual, community, and society, because the steps it consists of can be followed to identify the interventions and policies needed to address the problem. Furthermore, it can be linked to behavior change techniques when interventions are identified¹⁴⁾ and used in clinical practice. Regarding the “low concern about NAFLD” identified in the present study, providing information about the health and social effects of NAFLD and feedback about one’s lifestyle may be an effective behavior change technique. The identified barriers in the present study should be considered when designing and implementing efficient and effective interventions to modify the lifestyle of patients with NAFLD. However, because of the wide range of barriers identified, the problems need to be narrowed down based on the cultural and social context of the region where the intervention will be implemented. In the present study, we attempted to compare barriers to lifestyle modifications in patients with NAFLD in Western countries, such as the United Kingdom and the United States, and in Asian countries, such as South Korea and India. However, we could not identify regional differences or examine region-specific barriers and interventions. Further studies focusing on Asian countries might help unravel region-specific barriers, as most of the literature included in the present study was conducted in Western countries, and only a few were conducted in Asian countries. In addition, an evaluation of the effectiveness of interventions and their implementation consistent with the identified problems would be desirable in future studies.

This study has several limitations. First, a systematic search was conducted using a scoping review methodology. However, owing to the limited number of available databases, not all studies were included. Second, this scoping review examined the extent, range, and nature of the topics and summarized and disseminated the results of the studies; however, it did not assess the quality of the studies. There-

fore, studies with varying quality levels might be included. Finally, the relationships among the identified barriers were unclear; therefore, it was impossible to rank the importance of the barriers.

Conclusions

The COM-B model could be applied to improve the understanding of various barriers to lifestyle modifications in patients with NAFLD. Comprehension of barriers using the COM-B model, consisting of capability, opportunity, and motivation, may help generate appropriate care and education strategies to promote behavioral changes among patients with NAFLD.

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Author contributions: KS conceived and designed the study. KS conducted the literature search and KS and CF performed the screening. KS drafted, coded, analyzed, and wrote the final manuscript. CF, MS, TS, and HT supported the analysis and improved the manuscript. All authors have checked and approved the final version of the manuscript.

References

1. Riazi K, Azhari H, Charette JH, *et al.* The prevalence and incidence of NAFLD worldwide: a systematic review and meta-analysis. *Lancet Gastroenterol Hepatol* 2022; 7: 851–861. [Medline] [CrossRef]
2. Younossi ZM. Non-alcoholic fatty liver disease—a global public health perspective. *J Hepatol* 2019; 70: 531–544. [Medline] [CrossRef]
3. Mantovani A, Csermely A, Petracca G, *et al.* Non-alcoholic fatty liver disease and risk of fatal and non-fatal cardiovascular events: an updated systematic review and meta-analysis. *Lancet Gastroenterol Hepatol* 2021; 6: 903–913. [Medline] [CrossRef]
4. Björkström K, Widman L, Hagström H. Risk of hepatic and extrahepatic cancer in NAFLD: a population-based cohort study. *Liver Int* 2022; 42: 820–828. [Medline] [CrossRef]
5. Younossi ZM, Corey KE, Lim JK. AGA Clinical practice update on lifestyle modification using diet and exercise to achieve weight loss in the management of nonalcoholic fatty liver disease: expert review. *Gastroenterology* 2021; 160: 912–918. [Medline] [CrossRef]
6. Kamada Y, Takahashi H, Shimizu M, *et al.* Japan Study Group of NAFLD (JSG-NAFLD) Clinical practice advice on lifestyle modification in the management of nonalcoholic fatty liver disease in Japan: an expert review. *J Gastroenterol* 2021; 56: 1045–1061. [Medline] [CrossRef]
7. Hannah WN Jr, Harrison SA. Lifestyle and dietary interventions in the management of nonalcoholic fatty liver disease. *Dig Dis Sci* 2016; 61: 1365–1374.

- [Medline] [CrossRef]
8. Fernández T, Viñuela M, Vidal C, *et al.* Lifestyle changes in patients with non-alcoholic fatty liver disease: a systematic review and meta-analysis. *PLoS One* 2022; 17: e0263931. [Medline] [CrossRef]
 9. Kenneally S, Sier JH, Moore JB. Efficacy of dietary and physical activity intervention in non-alcoholic fatty liver disease: a systematic review. *BMJ Open Gastroenterol* 2017; 4: e000139. [Medline] [CrossRef]
 10. Leoni S, Tovoli F, Napoli L, *et al.* Current guidelines for the management of non-alcoholic fatty liver disease: a systematic review with comparative analysis. *World J Gastroenterol* 2018; 24: 3361–3373. [Medline] [CrossRef]
 11. Neuschwander-Tetri BA. Therapeutic Landscape for NAFLD in 2020. *Gastroenterology* 2020; 158: 1984–1998.e3. [Medline] [CrossRef]
 12. Vilar-Gomez E, Martinez-Perez Y, Calzadilla-Bertot L, *et al.* Weight loss through lifestyle modification significantly reduces features of nonalcoholic steatohepatitis. *Gastroenterology* 2015; 149: 367–78.e5, quiz e14–e15. [Medline] [CrossRef]
 13. Hallsworth K, Adams LA. Lifestyle modification in NAFLD/NASH: facts and figures. *JHEP Rep* 2019; 1: 468–479. [Medline] [CrossRef]
 14. Michie S, Atkins L, West R. *The behaviour change wheel a guide to designing interventions.* Silverback Publishing, Surrey, 2014; 57–63.
 15. Michie S, van Stralen MM, West R. The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implement Sci* 2011; 6: 42. [Medline] [CrossRef]
 16. Ning Y, Wang Q, Ding Y, *et al.* Barriers and facilitators to physical activity participation in patients with head and neck cancer: a scoping review. *Support Care Cancer* 2022; 30: 4591–4601. [Medline] [CrossRef]
 17. McDonagh LK, Saunders JM, Cassell J, *et al.* Application of the COM-B model to barriers and facilitators to chlamydia testing in general practice for young people and primary care practitioners: a systematic review. *Implement Sci* 2018; 13: 130. [Medline] [CrossRef]
 18. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Sci Res* 2005; 8: 19–32.
 19. Tricco AC, Lillie E, Zarin W, *et al.* PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med* 2018; 169: 467–473. [Medline] [CrossRef]
 20. Arora C, Malhotra A, Ranjan P, *et al.* Perceived barriers and facilitators for adherence to lifestyle prescription: perspective of obese patients with non alcoholic fatty liver disease from north India. *Diabetes Metab Syndr* 2021; 15: 102138. [Medline] [CrossRef]
 21. Avery L, Exley C, McPherson S, *et al.* Lifestyle behavior change in patients with nonalcoholic fatty liver disease: a qualitative study of clinical practice. *Clin Gastroenterol Hepatol* 2017; 15: 1968–1971. [Medline] [CrossRef]
 22. George ES, Forsyth AK, Reddy A, *et al.* A Mediterranean and low-fat dietary intervention in non-alcoholic fatty liver disease patients: exploring participant experience and perceptions about dietary change. *J Hum Nutr Diet* 2023; 36: 592–602. [Medline] [CrossRef]
 23. Glass O, Liu D, Bechar E, *et al.* Perceptions of exercise and its challenges in patients with nonalcoholic fatty liver disease: a survey-based study. *Hepatol Commun* 2022; 6: 334–344. [Medline] [CrossRef]
 24. Haigh L, Bremner S, Houghton D, *et al.* Barriers and facilitators to Mediterranean diet adoption by patients with nonalcoholic fatty liver disease in Northern Europe. *Clin Gastroenterol Hepatol* 2019; 17: 1364–1371.e3. [Medline] [CrossRef]
 25. Hallsworth K, Dombrowski SU, McPherson S, *et al.* Using the theoretical domains framework to identify barriers and enabling factors to implementation of guidance for the diagnosis and management of nonalcoholic fatty liver disease: a qualitative study. *Transl Behav Med* 2020; 10: 1016–1030. [Medline] [CrossRef]
 26. Heredia NI, Thrift AP, Balakrishnan M. Perceived barriers to weight loss among Hispanic patients with non-alcoholic fatty liver disease. *Hisp Health Care Int* 2022; 20: 171–178. [Medline] [CrossRef]
 27. Jang Y, Lee JY, Kim SU, *et al.* A qualitative study of self-management experiences in people with non-alcoholic fatty liver disease. *Nurs Open* 2021; 8: 3135–3142. [Medline] [CrossRef]
 28. O'Gorman P, Monaghan A, McGrath M, *et al.* Determinants of physical activity engagement in patients with nonalcoholic fatty liver disease: the need for an individualized approach to lifestyle interventions. *Phys Ther* 2021; 101: pzaa195. [Medline] [CrossRef]
 29. Scragg J, Hallsworth K, Taylor G, *et al.* Factors associated with engagement and adherence to a low-energy diet to promote 10% weight loss in patients with clinically significant non-alcoholic fatty liver disease. *BMJ Open Gastroenterol* 2021; 8: e000678. [Medline] [CrossRef]
 30. Stine JG, Soriano C, Schreiber I, *et al.* Breaking down barriers to physical activity in patients with nonalcoholic fatty liver disease. *Dig Dis Sci* 2021; 66: 3604–3611. [Medline] [CrossRef]
 31. Tincopa MA, Wong J, Fetters M, *et al.* Patient disease knowledge, attitudes and behaviours related to non-alcoholic fatty liver disease: a qualitative study. *BMJ Open Gastroenterol* 2021; 8: e000634. [Medline] [CrossRef]
 32. Frost H, Campbell P, Maxwell M, *et al.* Effectiveness of Motivational Interviewing on adult behaviour change in health and social care settings: a systematic review of reviews. *PLoS One* 2018; 13: e0204890. [Medline] [CrossRef]
 33. Mazzotti A, Caletti MT, Brodosi L, *et al.* An internet-based approach for lifestyle changes in patients with NAFLD: two-year effects on weight loss and surrogate markers. *J Hepatol* 2018; 69: 1155–1163. [Medline] [CrossRef]
 34. Zhou K, Fitzpatrick T, Walsh N, *et al.* Interventions to optimise the care continuum for chronic viral hepatitis: a systematic review and meta-analyses. *Lancet Infect Dis* 2016; 16: 1409–1422. [Medline] [CrossRef]
 35. Nazareth S, Leembruggen N, Tuma R, *et al.* Nurse-led hepatocellular carcinoma surveillance clinic provides an effective method of monitoring patients with cirrhosis. *Int J Nurs Pract* 2016; 22(Suppl 2): 3–11. [Medline] [CrossRef]
 36. Fowell AJ, Fancey K, Gamble K, *et al.* Evaluation of a primary to secondary care referral pathway and novel nurse-led one-stop clinic for patients with suspected non-alcoholic fatty liver disease. *Frontline Gastroenterol* 2020; 12: 102–107. [Medline] [CrossRef]
 37. Isoda H, Eguchi Y, Takahashi H. Hepatitis medical care coordinators: comprehensive and seamless support for patients with hepatitis. *Glob Health Med* 2021; 3: 343–350. [Medline] [CrossRef]
 38. Wang ML, Pbert L, Lemon SC. Influence of family, friend and coworker social support and social undermining on weight gain prevention among adults. *Obesity (Silver Spring)* 2014; 22: 1973–1980. [Medline] [CrossRef]
 39. van der Put A, Ellwardt L. Employees' healthy eating and physical activity: the role of colleague encouragement and behaviour. *BMC Public Health* 2022; 22: 2004. [Medline] [CrossRef]
 40. Gu Y, Zhou R, Kong T, *et al.* Barriers and enabling factors in weight management of patients with nonalcoholic fatty liver disease: a qualitative study using the COM-B model of behaviour. *Health Expect* 2023; 26: 355–365. [Medline] [CrossRef]