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SYSTEMATIC REVIEW
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Nutritional Challenges and Dietary Practices of Ethnic Minority (Indigenous) Groups in China: A Critical Appraisal

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Indigenous food systems can affect multiple aspects of Indigenous people's health. In China, the government declared that there are no Indigenous people in China and used the term "ethnic minority groups" instead. However, to date, no attempt has been made to investigate the nutrition status and dietary practices of all 55 ethnic minority groups. To understand this pertinent issue, a systematic review is required. The main selection criteria were publications should be about nutrition status or dietary practices among ethnic minority groups in China, specify the name of the ethnic minority group, and be published within the past 10 years. For this literature review, 111 publications were selected through Wanfang Med Online for Chinese publications and Google Scholar for English publications. Linear regressions were applied to explore what factors can affect the total number of publications for an ethnic minority group. The main findings include that only 15 ethnic minority groups have dietary intake data representing the general people of the ethnic group; only seven ethnic minority groups have data for both nutrition status (anthropometric and nutrients intake/deficiency) and dietary practices (dietary intake and dietary habits); there are still 10 ethnic minority groups with a total number of population 845,420 that lack studies on both nutrition status and dietary practices; ethnic minority groups are suffering from double-burden malnutrition and consuming unbalanced diets; primary and middle school students are the most prevalent study population than any other age group due to easy access; and an ethnic minority group is likely to have more publications about nutrition status and dietary practices if they have a larger population or are unique to a region. The results indicate that more national-level programs and timely nutrition and dietary reports should be implemented to address double-burden malnutrition and unbalanced diets among ethnic minority groups in China. More studies involving maternal nutrition, targeting underrepresented ethnic minority groups and age groups, and exploring traditional food systems in China are also essential to better understand and address this issue.

Keywords: Indigenous nutrition, ethnic minority, China, dietary practices, nutrition status, double-burden malnutrition, traditional food systems

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INTRODUCTION

Indigenous peoples are ethnic groups who are native to traditional lands with unique cultures, and relationships with people and the environment (The United Nations, 2015). Although the Chinese government officially declared in the 1990s that there are no Indigenous people in China and used the term ethnic minorities instead, some authoritative organizations like the United Nations (UN) include these Chinese ethnic groups as Indigenous peoples (Hathaway, 2016). Indigenous peoples' food systems involve valuable knowledge of traditional cultures and local ecosystems (Kuhnlein et al., 2009, p. 3). An Indigenous food system is essential to Indigenous peoples' health, including physical, emotional, mental, and spiritual parts of health (Kuhnlein, 2009, p. 3). Therefore, the study on Indigenous nutrition and traditional food systems is particularly important to Indigenous peoples' health and general livelihoods.

According to the Bulletin of the Seventh National Census in China, China has 55 ethnic minority groups (Chen, 2021). The total number of ethnic minority people in China is 125,467,390, accounting for 8.89% of the total population (Chen, 2021). Although the Chinese government has implemented many strategies to support the livelihoods of ethnic minority groups (The State Council Information Office of the People's Republic of China, 1999), health inequality has still been reported between ethnic minority groups and the Han main group (Ouyang and Pinstrup-Andersen, 2012; Ouyang, 2013). For example, the infant and child mortality rates of the western part of China where most of the Indigenous people inhabit are significantly higher than other regions (Ma et al., 2010). In terms of Indigenous nutrition and traditional food systems in China, fishing-hunting, animal husbandry, and agricultural farming are identified as three different dietary structures among ethnic minority groups (Liu and Zhai, 2004). Dietary unbalance is common in different dietary structures (Zhai et al., 2007), and malnutrition is common in different ethnic minority groups (Ma et al., 2010). Multiple factors have been reported to affect the nutrition status and dietary practices, such as the loss of cultural knowledge and agricultural resources (Zheng et al., 2012), family size, education (Qu et al., 2013), income (Wang C. et al., 2013), the lack of nutritional knowledge (Zhang and Wang, 2012), genetic differences, dietary differences, physical activities (Guo et al., 2016), geographical differences, environment, religions (Zhai et al., 2007), and economic development (Zhai et al., 2007; Zhang et al., 2008).

Considering the malnutrition, unbalance in dietary intake, health inequality, and a large number of the ethnic minority population in China, it is essential to pay attention to the nutrition status and dietary intake of ethnic minority people. Although there are publications related to this topic in recent years, none of them aim to discuss all ethnic minorities and compare the differences and changes from a broad perspective. Only eight of them are published in English (Gao et al., 2011; Zhang C. X. et al., 2012; Jingya et al., 2013; Qu et al., 2013; Wang C. et al., 2013; Guo et al., 2016; Dong et al., 2018; Zhang et al., 2018). The current literature review summarizes both Chinese and English publications related to the nutrition status and dietary practices among ethnic minority groups and discusses the causes of and potential solutions to malnutrition and other concerns caused by current dietary practices. The result of the current review will contribute to international scholars' understanding of the nutrition and dietary status of Chinese ethnic minorities and help policymakers to improve nutrition status and dietary balance. Considering the fast growth of Chinese gross domestic products (GDP) (The World Bank, 2020), and the fact that economic status is a key factor in affecting nutrition status (Zhang et al., 2018), only publications in the past 10 years are included. The research questions of the current review are:

1. What is the nutrition status (anthropometric results and nutrient intake/deficiency) of ethnic minority groups in China in the past 10 years?
2. What are the dietary practices (dietary intake and habits) of ethnic minority groups in China in the past 10 years?

FIGURE 1 | The distribution of publications of nutrition status among ethnic minority groups in China from 1998 to 2021 (generated by Wanfang Med Online).

METHOD

Literature Selection Criteria

The current review is a literature review of Chinese and English publications related to the research questions. The search engine used to collect Chinese literature was Wanfang Med Online (万方医学网), which provided the most complete and important medical journal resources and other resources (Wanfang Med Online, 2013). The keywords for searching were Ethnic Minority and Nutrition (少数民族；营养), followed by Ethnic Minority and Diet (少数民族；膳食).

In total, in August 2021, 703 papers were identified when searching for Ethnic Minority and Nutrition. The first publication related to this topic was in 1998. The number of publications on this topic peaked in 2013 and then gradually decreased (**Figure 1**). When searching for Ethnic Minority and Diet, the total number of publications was 371 with a similar trend of numbers of annual publications (**Figure 2**). After the first search attempt, if there were no ethnic minorities identified, then the name of each specific ethnic minority group was

FIGURE 2 | The distribution of publications of dietary practices among ethnic minority groups in China from 1998 to 2021 (generated by Wanfang Med Online).

searched with Nutrition and Diet, respectively, to ensure that no publications about these topics were missed.

Among all publications, the first criterion was selecting publications only in the past 10 years from 2011 to 2021. This was due to the rapid growth of the Chinese GDP (The World Bank, 2020), and the nutrition status of each ethnic minority group significantly changing (Guo et al., 2016). However, if the publications targeted the general trend of nutrition status and dietary practices in a specific period, or if the publications could show a broad overview of the nutrition and diet of the Chinese ethnic minority groups, the publications were then included. Also, if an ethnic minority group did not have publications within the last 10 years, then the most recent publication was selected, even if the article had been published before 2011.

The second criterion was that only publications that specified the names of ethnic minority groups were included because different ethnic cultures have an influence on dietary practices (Liu and Zhai, 2004). If studies only specified an ethnic minority region without the names of ethnic minority groups, they were excluded.

The third criterion was that all selected studies should target people in good health. For example, if a study population included people with cardiovascular diseases, diabetes, or other diseases, they were excluded. This is because some medical treatments include dietary recommendations and restrictions (Heilberg, 2000).

Finally, some undernutrition data such as stunting, and wasting were derived from published physical exams. For such publications, only data related to nutrition were selected. Other results of physical exams, such as eyesight and blood pressure, were excluded.

Google Scholar was used to collected English publications. The same keywords translated into English plus Chinese were utilized for the search. After applying the same criteria to Chinese publications, only eight English publications were identified, and eight Chinese publications had English abstracts. There were also eight English publications that discussed the nutrition status and dietary intake of ethnic minority groups in China but did not specify the particular ethnic minority group.

The details for every step of the selection process are summarized in a PRISMA flow diagram as shown in **Figure 3**.

DATA ANALYSIS

After selecting the relevant publications, the total number and those for each theme, sub-theme, and age group were counted. Themes were generated from the research questions: nutrition status and dietary practices. Sub-themes and age groups were generated during the literature review. Finally, 11 sub-themes and 12 age groups were identified and are shown in the Results section.

Subsequently, the number of total publications, plus basic information (total population, major distribution, and the rank of total population) for each ethnic minority group, were recorded in **Table 1**. Linear regression was utilized to analyze the relationship between the rank of total populations for each ethnic minority group and the numbers of total publications, region-level, and country-level publications, respectively to identify significant outliers and analyze relevant factors that affect the numbers of publications. The country-level publication describes the targeted ethnic minority groups in a publication distributed around China; and the region-level publication describes the targeted ethnic minority groups in a publication as only one specific ethnic minority group or living in a region (such as a town, city, or province).

Thematic analysis was used to summarize results from the selected literature. If publications met the selection criteria, the information about key results, related to specific themes, was summarized according to each ethnic minority group. The details were recorded in Attachment 1.

RESULTS

After applying the selection criteria, 111 publications were selected for the final analysis. Each article targeted from one up to 26 ethnic minority groups. Among them, 98 publications reported results about nutrition status, and 46 publications discussed dietary practices. Xinjiang Province had the most publications (25 publications) related to these two themes, followed by Yunnan Province with 22 publications. There were also 12 publications (eight of them were from Yunnan Province) that discussed nutrition interventions among ethnic minority groups in China, but they were excluded from the analysis because they were irrelevant to the research questions. Also, although all of the selected publications specified the names of the ethnic minority groups, only one of the publications (Chan et al., 2019) identified the specific branch of each ethnic minority group (e.g., Kunge people in Blang ethnic minority group, Yunnan Province).

Eleven sub-themes were identified. The sub-themes included undernutrition (low weight, stunting, and wasting), overnutrition (overweight and obesity), double-burden malnutrition, nutrient intake/deficiency, dietary intake, breastfeeding, dietary habits, nutrition knowledge, comparison with the Han main ethnic group (the Han group must be selected as study population for comparison), trends of nutrition status, and whether risk factors were the focus of research questions (the study should discuss risk factors rather than only calculating some social-demographic factors such as ethnicity, age, and sex)

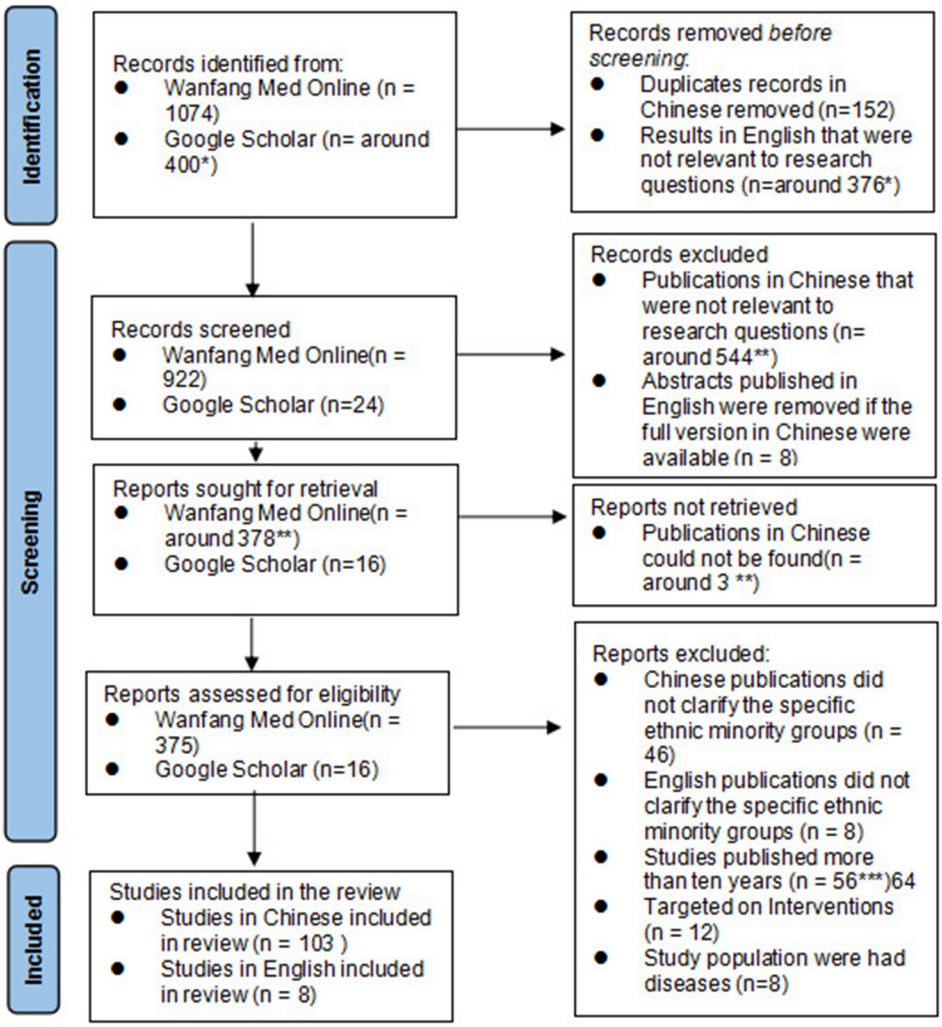

FIGURE 3 | The PRISMA flow diagram for the details of the literature selection process. *When using keywords searched in Google Scholar, there were more than 400,000 results in total. It was very difficult to identify them all. Because the following listed results were increasingly irrelevant to the beginning listed results, if there were continuously 100 results that were not relevant, the identification process will be terminated. Finally, around 400 results were identified by the first author. **The current review was edited based on a student course essay. The PRISMA flow diagram was provided during the submission review and formed based on research notes and memory. Thus, three numbers in the flow diagram were based on recall and may not be accurate, but it will not affect the literature review and the results. ***The total number of studies published more than 10 years was 64. However, eight of them were either related to the general trends of nutrition status and dietary practices in a specific period or the most recent publication for a specific ethnic minority group. Therefore, these eight publications were finally included.

(Shi, 2014). Undernutrition was the most frequent sub-theme; more than half of the total publications (60 out of 111) discussed undernutrition. Overnutrition was the second most popular sub-theme with 46 publications. Double-burden malnutrition was also widely reported by 40 publications. Dietary intake and nutrient intake/deficiency were also popular sub-themes and were reported in 36 and 34 of the publications, respectively. There were 29 publications comparing nutrition status and dietary practices with the Han main group. Only seven of them concluded that the Han main group had a better nutrition status or dietary practices than ethnic minority groups, while 15 publications showed that the Han main group only partially had better nutrition status or dietary practices in the studies; three publications concluded that the results of the Han main group and ethnic minorities were similar. Discussing risk factors related to nutrition status and dietary practices ($n = 20$) and the trends of nutrition status and dietary practices ($n = 17$), and dietary habits ($n = 16$) were also common. However, nutrition knowledge ($n = 6$) and breastfeeding ($n = 3$) were less frequent topics. **Table 1** provides a detailed analysis of the reviewed articles.

In terms of study populations, 12 age groups were identified; the details of different age categories were shown in **Table 1**. Because the ages for school in China can be different, the age

TABLE 1 | Information about publications, themes, sub-themes, and study populations.

Total publications reviewed	111
Themes	98
Nutrition status	
Dietary practices	46
Sub-themes	60
Undernutrition	
Overnutrition	46
Double-burden malnutrition	39
Dietary intake	36
Nutrients intake/deficiency	34
Comparison with the Han Main Group	29 (The Condition of the Han Main Group is better: 7; The Condition of the Han Main Group is worse: 4; The Condition of the Han Main Group is better in some areas: 15; The Condition of the Han Main Group is similar: 3)
Risk factors	20
Trends of nutrition status	17
Dietary habits	16
Nutrition knowledge	6
Breastfeeding	3
Study Populations	41
Primary school students (always 7–12 years old)	
Middle school students (always 13–18 years old)	41
Children (always 2–6 years old)	17
College students (always 18–22 years old)	12
Infants (always 0 to 2 years old)	10
Peripartum women	9
Adults	8
General ethnic population	6
The elders	4
Mother-infant breastfeeding dyads	4
Middle-age people	2
Women	2

range for primary school, middle school, and college students may overlap.

Primary and middle school students had a much larger number of publications than other study populations with each having 41. The number of publications discussing the nutrition status or dietary practices of children, college students, and infants was also considerable at 17, 12, and 10, respectively. Only nine publications focused on peripartum women, and six publications utilized general ethnic groups as the study population. The numbers of publications of other populations are shown in **Table 1**.

When discussing the publications related to research questions of each ethnic minority group, as shown in **Table 2**, 45 groups presented data about nutrition status or dietary practices available in the past 10 years. The Uygur group had the largest number of total publications at 29. There were 17 articles about the Miao group, 16 about the Tibetan group, and 15 about the Zhuang group. The Bai, Dai, Tujia, Hui, Kazak, Yi, and Naxi groups also had more than 10 publications related to the two research questions. Thirty-four ethnic minority groups had less than 10 total publications related to these issues. The remaining 10 ethnic minority groups (the Tajik, Xibo, Tatar, Hezhe, Uzbek, Gelao, Menba, Lhoba, Russian, and Gaoshan groups) did not report on these themes, and five of these groups lived in Xinjiang Province, which is the largest province in China. The total population of these 10 ethnic minority groups was 845,420. Gelao peoples comprised the largest ethnic minority group without any publications related to the research questions, followed by the Xibo and Tajik groups. **Table 2** provides greater detail about the total numbers of publications, total population sizes, the ranks of the total population, major areas of residency, and key publications related to the research questions for each ethnic minority group.

The linear regression was utilized to explore what factors affect the total number of publications for each ethnic minority group, as shown in **Figure 4**. The independent variable (the Rank of Total Populations) can explain 50.5% (R square = 0. 5051) of the movements of the dependent variable (numbers of publications for the ethnic minority group) in a negative linear regression model. However, significant outliers do exist. For example, the total population of the Uygur group ranked fourth, but the Uygur group had a much larger number of total publications than any other ethnic minority group. The Manchu group had the third-largest population, but only one publication was related to the research questions. The Dai, Naxi, Yugur, and Dulong groups also had more publications than the linear regression expectation, while the She, Gelao, and Xibo groups had fewer numbers of publications according to the equation.

To further understand what factors affect the total number of publications for each ethnic minority group, **Figures 5**, **6** show the relationship between the rank of the total number of publications and the number of country/region-level publications. Ethnic minority groups with greater populations are also more likely to be selected for analysis for country-level publications (R square = 0.64). The Manchu group, including 10,387,958 people (as shown in the distribution of **Figure 5**) is an exception with only one country-level publication (UNC University Libraries, 2021). The distribution of region-level (**Figure 6**) shows that even ethnic minority groups with small numbers of people could yield considerable numbers of region-level publications, such as the Yugur and Dulong groups. However, the Uygur group is still the ethnic minority group with the largest number of publications for both country-level and region-level publications.

The results of nutrition status and dietary practices of each ethnic minority group are summarized and shown in Attachment 1. Four categories (anthropometry, nutrients intake/deficiency, dietary intake, and dietary habits) were generated to show the key results from the 111 selected publications among 45 ethnic minority groups in China. Only seven ethnic minority groups (the Bai, Bouyei, Dongxiang,

TABLE 2 | Information about numbers of publications, total populations, and major areas of distribution for each ethnic minority group.

The ethnic minority groups	Numbers of total publications	Numbers of publications from region-level*	Numbers of publications from country-level**	Total population sizes	The ranks of total population	Major areas of residency	Key publications related to research questions
Uygur	29	20	9	10,069,346	4	Xinjiang	Zhai et al., 2007; Gu et al., 2013; He, 2013; Zhang, 2014; Zhang T. et al., 2014; Wu et al., 2015; Li T. et al., 2016; Liu et al., 2016; Zhong and Ma, 2017; and more
Miao	17	12	5	9,426,007	5	Guizhou, Hunan, Yunnan, Guangxi, Sichuan, Hainan, Hubei, Guangdong	Zhai et al., 2007; Li et al., 2011; Zhang F. et al., 2012; Fang et al., 2013; Ji and Yin, 2014b; Zhang and Zhang, 2014; Huang et al., 2020; and more
Tibetan	16	8	8	6,282,187	8	Tibet, Qinghai, Sichuan, Gansu, Yunnan	Zhai et al., 2007; Bai et al., 2018; Tao, 2019; Pubu et al., 2020; Wang and Shen, 2020; and more
Zhuang	15	7	8	16,926,381	1	Guangxi, Yunnan, Guangdong, Guizhou, Hunan	Zhai et al., 2007; Ma et al., 2009; Wei and Huang, 2011; Jiang et al., 2013; Wei and Wei, 2013 and more
Bai	14	10	4	1,933,510	7	Yunnan	Li et al., 2012; Yang et al., 2013; Li and Zhang, 2014; Zhang X. F. et al., 2014; and more
Dai	14	10	4	1,261,311	13	Yunnan	Zhou and Kang, 2016; Zhao et al., 2017; Lin et al., 2018; Lei et al., 2019; and more
Tujia	14	10	4	8,353,912	18	Hunnan, Hubei, Guizhou, Chongqing	Zhai et al., 2007; Zhang F. et al., 2011; Zhang et al., 2013; Zhou, 2016; Zhou Y. et al., 2016; Dai et al., 2019; and more
Hui	13	6	7	10,586,987	2	Concentrated in the Northwestern provinces such as Ningxia, Gansu, Qinghai, and Xinjiang; Communities of Hui are all over the country	Zhai et al., 2007; Wen and Zhang, 2010; Zhang and Wang, 2012; Li, 2015; Wang, 2018; and more
Kazak	12	8	4	1,462,588	17	Xinjing, Gansu, Qinghai	Zhai et al., 2007; Wen and Zhang, 2010; Gu et al., 2013, 2014; Li et al., 2015; Liu et al., 2019; and more
Yi	10	5	5	8,714,393	6	Sichuan, Yunnan, Guizhou, Guangxi	Wang, 2010; Li et al., 2012; Yang et al., 2013; and more
Naxi	10	6	4	326,295	26	Yunnan, Sichuan	Li and Hu, 2015; Shen et al., 2020; Fu et al., 2021; and more
Bouyei	9	4	5	2,870,034	9	Guizhou, Yunnnan, Sichuan	Zhai et al., 2007; Dong et al., 2018; Yu et al., 2018; and more
Mongol	9	2	7	5,981,849	11	Inner Mongolia, Liaoning, Jilin, Hebei, Xinjiang, Heilongjian, Qinghai, Henan	Zhai et al., 2007; Ma et al., 2009; Yang et al., 2012; Zhang and Wang, 2012; Wang et al., 2018; and more

(Continued)

TABLE 2 | Continued

The ethnic minority groups	Numbers of total publications	Numbers of publications from region-level*	Numbers of publications from country-level**	Total population sizes	The ranks of total population	Major areas of residency	Key publications related to research questions
Wa	9	6	3	429,709	12	Yunnan	Yang et al., 2012, 2015; Guo and Zhao, 2013; Li and Hu, 2015; Shen et al., 2020; and more
Yao	9	5	4	2,796,003	24	Guangxi, Hunan, Yunna, Guangdong, Guizhou	Zhai et al., 2007; Li T. et al., 2016; Zhou Y. et al., 2016; and more
Dongxiang	8	5	3	621,550	15	Gansu, Ningxia, Qinghai, Xinjiang	Zhou et al., 2011a, 2019; Wang C. et al., 2013; Li T. et al., 2016; and more
Hani	8	5	3	1,660,932	20	Yunnan	Guo and Zhao, 2013; Li and Hu, 2015; Shen et al., 2020; and more
Lisu	8	5	3	702,839	21	Yunnan, Sichuang	Li and Hu, 2015; Dai et al., 2018; Shen et al., 2020; and more
Korean	7	1	6	1,830,929	14	Jilin, Liaoning, Heilongjiang, Beijing Korean Town	Ma et al., 2009; Jin et al., 2012; Guo et al., 2016; and more
Blang	6	6	0	119,639	10	Yunnan	Luo et al., 2013; Chan et al., 2019; Shen et al., 2020; and more
Dong	6	2	4	2,879,974	16	Guizhou, Hunan, Guangxi	Ji and Zhang, 2014; Xie, 2015; Guo et al., 2016; and more
Li	6	2	4	1,463,064	25	Hainan	Shi et al., 2012; Zhang C. X. et al., 2012 Lei et al., 2019; and more
Shui	6	2	4	411,847	35	Guizhou, Guangxi	Ji and Yin, 2014a; Guo et al., 2016; Yu et al., 2018; Lei et al., 2019; and more
Yugur	6	6	0	14,378	47	Gansu	Zhang X. et al., 2011; Zhou et al., 2011a,b; Wang Y. et al., 2013; Bu, 2014; Zhou and Wang, 2018; and more
Dulong	5	5	0	6,930	28	Yunnan	Li and Hu, 2015; Dai et al., 2018; Shen et al., 2020; and more
Jino	5	5	0	23,143	31	Yunnan	Luo et al., 2013; Li and Hu, 2015; Yang et al., 2018; and more
Kirgiz	5	2	3	186,708	34	Xinjiang, Heilongjiang	Wen and Zhang, 2010; Guo et al., 2016; Yao et al., 2020; and more
Nu	5	5	0	37,523	40	Yunnan	Yang et al., 2012; Li and Hu, 2015; Zhao J. et al., 2019; Shen et al., 2020; and more
Salar	5	1	4	130,607	43	Qinghai, Gansu, Xinjiang	Wen and Zhang, 2010; Guo et al., 2016; Lei et al., 2019; and more

(Continued)

TABLE 2 | Continued

The ethnic minority groups	Numbers of total publications	Numbers of publications from region-level*	Numbers of publications from country-level**	Total population sizes	The ranks of total population	Major areas of residency	Key publications related to research questions
Tu	5	1	4	289,565	51	Qinghai, Gansu	Wen and Zhang, 2010; Guo et al., 2016; Lei et al., 2019; and more
Pumi	4	4	0	42,861	27	Yunnan	Li and Hu, 2015; Zhao Y. et al., 2019; Shen et al., 2020; and more
Qiang	4	1	3	309,576	38	Sichuan	Guo et al., 2016; Zuo et al., 2018; Lei et al., 2019; and more
Baoan	3	3	0	20,074	23	Gansu	Han et al., 2011; Yu et al., 2011; Zhou and Wang, 2019
Daur	3	3	0	131,992	29	Inner Mongolia, Heilongjian, Xinjiang	Hong et al., 2012; Ye, 2016
Lahu	3	3	0	485,966	33	Yunnan	Li and Hu, 2015; Shen et al., 2020
Maonan	3	3	0	101,192	36	Guangxi	Yu et al., 2014, 2018; Yang et al., 2016a,b,c
Mulao	3	3	0	216,257	45	Guangxi	Ju-qian, 2014; Yu et al., 2014; Zhang X. F. et al., 2014; Gong et al., 2017
Achang	2	2	0	39,555	32	Yunnan	Li and Hu, 2015; Shen et al., 2020
De'ang	2	2	0	20,556	39	Yunnan	Li and Hu, 2015; Shen et al., 2020
Ewenki	2	2	0	30,875	41	Inner Mongolia, Heilongjiang	Hong et al., 2012; Ye, 2016
Jingpo	2	2	0	147,828	44	Yunnan	Li and Hu, 2015; Shen et al., 2020
Orequn	2	2	0	8,659	50	Inner Mongolia, Heilongjiang	Hong et al., 2012; Ye, 2016
Manchu	1	0	1	10,387,958	3	Liaoning, Jilin, Heilongjiang, Hebei, Beijing, Inner Mongolia	Zhai et al., 2007
She	1	1	0	708,651	19	Fujian, Zhejiang, Jiangxi, Guangdong, Anhui	Chen et al., 2017
Jing	1	1	0	28,199	42	Guangxi	Jiang et al., 2013
Gelao	0	0	0	550,746	22	Guizhou, Guangxi, Yunnan, Sichuan	N/A
Xibo	0	0	0	190,481	30	Xinjiang, Liaoning, Jilin	N/A
Tajik	0	0	0	51,069	37	Xinjiang	N/A
Russian	0	0	0	15,393	46	Xinjiang, Inner Mongolia, Heilongjiang	N/A
Uzbek	0	0	0	10,569	48	Xinjiang	N/A
Menba	0	0	0	10,561	49	Tibet	N/A
Hezhen	0	0	0	5,354	52	Heilongjiang	N/A
Gaoshan	0	0	0	4,009	53	Taiwan (population not counted), Fujian	N/A
Lhoba	0	0	0	3,682	54	Tibet	N/A
Tatar	0	0	0	3,556	55	Xinjiang	N/A

*The information about population and major area of distribution are from UNC University Libraries (2021). *Publications from region-level: the publications target on one specific ethnic minority group or target on ethnic minority groups in a region (a county, city, or province). **Publications from country-level: the publications are for national-level analysis. Always, the targeted ethnic minority groups are distributed around China.*

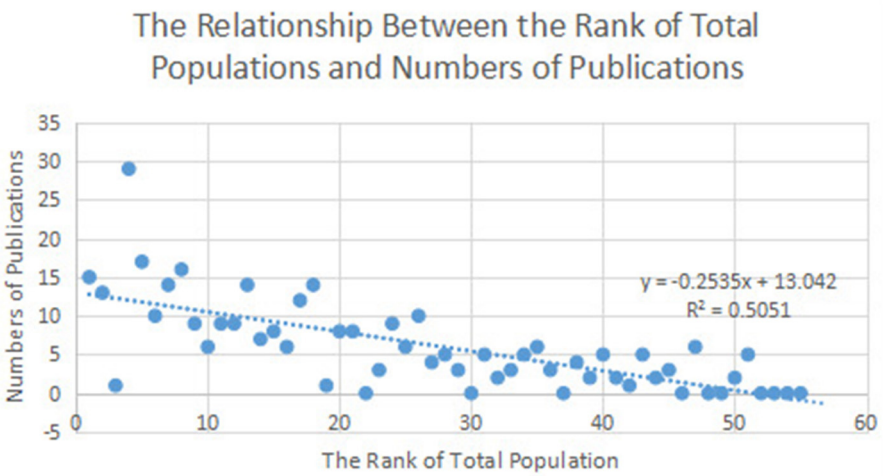

FIGURE 4 | The relationship between the rank of total populations and numbers of publications.

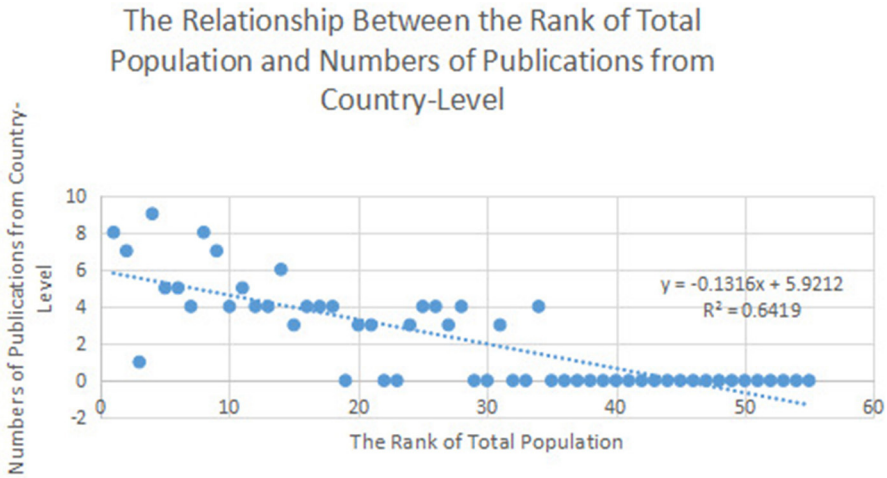

FIGURE 5 | The relationship between the rank of total population and numbers of publications from country-level.

Hazak, Miao, Nu, Uygur, and Zhuang groups) had results for all four categories.

Both region-level (see the references in Attachment 1) and country-level publications (Zhang et al., 2008; Guo et al., 2016; Dong et al., 2018; Lei et al., 2019) were identified that report anthropometric data (undernutrition and overnutrition). Thirty-two ethnic minority groups reported both the existence of undernutrition and overnutrition (double-burden malnutrition) and the changes in undernutrition/overnutrition rates in the selected literature. Twenty-seven of these 32 ethnic minority groups showed the trend that the undernutrition rate was decreasing while overnutrition was increasing during a time period (see the details and references in Attachment 1). Another five ethnic minority groups had different trends of undernutrition/overnutrition rates. More specifically, the Shui group showed an opposite trend. The undernutrition rate increased while the overnutrition decreased from 1991 to 2005 (Zhang et al., 2008). Both the undernutrition and overnutrition rates for the Tu group increased from 1995 to 2005 (Wen and Zhang, 2010). The existing literature only shows that the undernutrition rates of the Miao and Yao groups increased from 1991 to 2005, but lacks the data for the change in overnutrition rates that could represent the whole ethnic minority groups (Zhang et al., 2008). A study at Jinxiu Yao Autonomous County showed that the undernutrition rate of the Yao group increased while the overnutrition rate was stable from 2007 to 2012 (Li T. et al., 2016). For the rest 13 ethnic minority groups with existing literature on dietary practices or nutrition status, nine of the ethnic minority groups (the Baoan, Daur, Dongxiang, Ewenki, Madonna, Mule, Oreqen, Qiang, and Yi groups) reported both

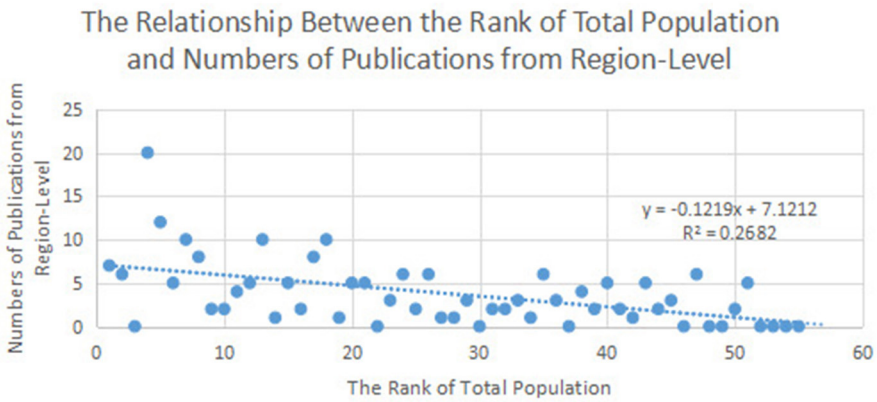

FIGURE 6 | The relationship between the rank of total population and numbers of publications from region-level.

undernutrition and overnutrition but did not report trends. Four ethnic minority groups (the Jing, Manchu, She, and Yugur groups) lack reports on undernutrition or overnutrition in the existing literature.

The results of nutrient intake/deficiency are available for 18 ethnic minority groups. The Uygur, Zhuang, and Miao groups provided more details about the results than the other 15 ethnic minority groups. Nutrients intake insufficiency, nutrient over-intake, and using blood testing to detect nutrient deficiency are three major topics for the results of nutrient intake/deficiency. Fourteen, six, and seven ethnic minority groups have results on these three topics, respectively. Iron was the most prevalent element reported among different ethnic minority groups in nutrients deficiency through blood samples (Yu et al., 2018; Huang et al., 2020), and sodium over-intake was reported most in nutrients over-intake (Jiang et al., 2013; Xie, 2015; Ka et al., 2018). The intake insufficiency of multiple nutrients was reported at least once among different ethnic minority groups. These nutrients included fat, protein, dietary fiber, energy, sodium, potassium, vitamin A (retinal), vitamin B1 (thiamine), vitamin B2 (riboflavin), vitamin C, vitamin D, vitamin E, calcium, niacin, zinc, iodine, folic acid, selenium, and magnesium (see details and references in Attachment 1). However, no publication was identified that summarized nutrient intake/deficiency among ethnic minority groups at the country level.

There were 19 publications that examined dietary intake including the intake of foods or food types and comparing with any dietary intake standards [such as dietary reference intake (DRI) and Reference Dietary Allowance (RDA)]. Only one country-level publication examined dietary intake for the general population of the ethnic minority groups and it has dietary intake information for 12 ethnic minority groups (the Mongol, Hui, Tibet, Uygur, Miao, Yi, Zhuang, Bouyei, Manchu, Yao, Tujia, and Kazak groups) (Zhai et al., 2007). The article was published in 2007, but is still the major source of results on dietary intake and thus was retained for analysis in the current review. The Uygur group remains the ethnic minority group with the most publications on this topic; the Tujia group and some Gansu Province-based ethnic minority groups such as the Yugur and Dongxiang groups also have considerable dietary intake information. Moreover, most publications about dietary intake only focused on one age group. Besides the 12 ethnic minority groups reported by Zhai et al. (2007) focused on the general ethnic minority group population, only the Jing, Nu, Naxi, and Zhuang groups have articles that discussed dietary intake conditions focusing on the general population of a specific ethnic minority group. At the level of the general population of a specific ethnic minority group, no ethnic minority group has a balanced diet.

Other diet-related behavior or practices are noted in the results of dietary habits, including exclusive breastfeeding, high-salt diet consumption, the consumption of pickled food, high-fat food, habits when buying foods, tea consumption, sweets consumption, breakfast consumption, meals per day, nutrition knowledge, causes for unbalanced diets, the influence of the Han main group or modernity, and more dietary habits. Exclusive breastfeeding is the most prevalent dietary habit and 18 ethnic minority groups have reported it. Fifteen of the 18 ethnic minority groups live in Yunnan Province and three of them are mainly distributed in the northeastern part of China. None of the ethnic minority groups practice 100% exclusive breastfeeding for 6 months after delivery. The Blang group had the lowest exclusive breastfeeding rate at only 9.8%, while the Nu, Ewenki, and Hani groups had exclusive breastfeeding rates more than 75% (77.1, 76.5, and 75%, respectively). However, although exclusive breastfeeding was the most prevalent dietary habit among different ethnic minority groups, only one article (Li and Hu, 2015) covered 15 ethnic minority groups in Yunnan Provinces.

In addition, the Uygur group has nine publications that focus on pregnant women and is the only ethnic group for which attention has focused on maternal nutrition. Both malnutrition (undernutrition and overnutrition) (Yuan, 2013) and unbalanced dietary structure (Maimaitiming et al., 2013) are reported. The intakes of seafood, vegetables, fruits, eggs, and milk are

insufficient, while the intakes of cereals and grains exceed the standard (Yan et al., 2019). Nutrients intake insufficiency is also reported, including potassium, iron, zinc, vitamin A, vitamin C, iodine, calcium, vitamin B1, vitamin B2, iodine, and folic acid (Sun et al., 2011; Maimaitiming et al., 2013; Yuan et al., 2013; Yang et al., 2016a,b,c; Ka et al., 2017, 2018). Two existing studies (Sun et al., 2011; Maimaitiming et al., 2013) proposed that more animal protein is needed to improve nutrition status and dietary balance.

DISCUSSION

The current study reviewed 111 selected publications about the nutrition status and dietary practices of ethnic minority groups in China. This study aimed to summarize the nutrition status and dietary practices of all 55 ethnic minority groups in China. However, it was limited due to a lack of data for 10 of the groups. The study shows that the Uygur, Miao, and Tibetan groups have the most publications related to nutrition status and dietary practices. Ethnic minority groups tend to have more total numbers of publications and country-level publications if they have a larger total population. Primary and middle school students are the two age groups with the most relevant publications. The results show that both double-burden malnutrition and diet unbalance are common among different age groups of Chinese ethnic minorities. The rate of undernutrition was generally decreasing while the rate of overnutrition was generally increasing in the past years. There is insufficient intake of multiple nutrients in many publications. Exclusive breastfeeding is the most prevalent reported dietary behavior and the rates are low among Chinese ethnic minority groups. Only the Uygur group has studies on pregnant women. When comparing with the Han main group, only 9 of 29 publications conclude that the Han main group has better nutrition status or dietary practices than ethnic minorities.

The current review summarizes nutrition status and dietary practice from a country-level perspective. Apart from the current review, the results of anthropometry were reported by five large-scale country-level publications. At least ten ethnic minority groups were included for each (Zhang et al., 2008; Ma et al., 2009; Guo et al., 2016; Dong et al., 2018; Lei et al., 2019). The five publications showed the prevalence of undernutrition, overnutrition, or double-burden malnutrition. Three existing studies (Zhang et al., 2008; Ma et al., 2009; Guo et al., 2016) showed the general trend that the undernutrition rate was decreasing while overnutrition was increasing in the past few years. The results aforementioned from existing literature are consistent with the results of the current review. Economic development of ethnic minority regions was proposed by Zhang et al. (2008) as the major cause of the prevalence of double-burden malnutrition and the trend of undernutrition and overnutrition rates. Development of tourism in ethnic minority regions, rapid urbanization, and cultural exchanges may also contribute to the increase in the overnutrition rate (Guo et al., 2016); high physical activity lifestyles may affect both undernutrition and overnutrition (Guo et al., 2016; Dong et al., 2018). The study by Guo et al. (2016) showed that the rates of undernutrition of the Han main group (4.2%) and ethnic minority groups (4.1%) were comparable in 2010, while the overnutrition rate of the Han main group was larger than in the ethnic minority groups (19.2 and 13.5%, respectively). This result is also consistent with the result of the current review that among 29 publications comparing the nutrition status or dietary practices of the Han main group and ethnic minority groups, only 7 publications conclude that the Han main group has better nutrition status or dietary practices than the ethnic minority groups. The remaining publications showed that the nutrition status or dietary practices of ethnic minority groups were comparable to or better than the Han main group. Genetic differences, different diets, more physical activities, and preferential policies and subsidies (Guo et al., 2016) among the ethnic minority groups could explain why the Han main group has a worse nutrition status than the ethnic minority groups in China.

Only one country-level article (Zhai et al., 2007) reported the dietary practices of multiple ethnic minority groups was found for the current review. Zhai et al. (2007) examined the dietary intake of the general population of 12 ethnic minority groups. Three region-level publications also showed the results of dietary intake of general ethnic minority people of the Nu (Zhao J. et al., 2019); Naxi (Fu et al., 2021), and Zhuang and Jing groups (Jiang et al., 2013). The results of these three publications are consistent with Zhai et al. study (Zhai et al., 2007) that the diets of ethnic minority groups are unbalanced.

The results of the linear regressions can be used to explore what factors may affect the studies and publications relevant to nutrition status and dietary practices among ethnic minority groups. Ethnic minority groups with large populations are more likely to have a country-level analysis. This may result from scholars' attention to the ethnic minority groups with larger populations, while ethnic minority groups with smaller populations lack publications, such as the Uzbek, Menba, Russian, Hezhen, Lhoba, and Tatar groups. The populations for these six ethnic minority groups are approximately or less than 15,000. However, ethnic minority groups, such as the Uygur, Dai, Naxi, Yugur, and Dulong groups, mainly live in only one province (UNC University Libraries, 2021). Even though some of them (such as the Dulong and Yugur groups) only have small numbers of the total population, they still have higher numbers of publications, especially in region-level publications. This may have occurred as an ethnic minority group is perceived as unique in a province; the local scholars may pay more attention to this ethnic minority group. For example, publications such as "Investigation on malnutrition and obesity of 0 ∼ 6-year-old children of 15 unique ethnic minorities in Yunnan" (Shen et al., 2020) and "Physical health status of college students from six unique ethnic minorities in Yunnan Province"(Bai et al., 2016) demonstrate this potential tendency in Yunnan Province through the titles using "unique". The Yi and Miao groups are larger ethnic minority groups than many others in Yunnan, but the Yi and Miao groups are not unique ethnic minority groups in Yunnan (People's Government of Yunnan Province, 2021). This may be the reason why no publications in Yunnan Province focus on the Yi and Miao groups, especially considering that

Yunnan is the province with the second most publications. The publications in Gansu Province and the northeastern part of China also present a similar tendency. In Gansu Province, the Yugur group only has 14,378 people but has six region-level publications. In the northeastern part of China, smaller but more unique ethnic minority groups such as the Oroqen, Ewenki, and Daur groups have more region-level publications than larger but non-unique ethnic minority groups such as the Mongol, Korean, and Manchu groups. The scholars also tend to work with the ethnic minority groups near their location. For example, Yu Wang is the corresponding author in most of the publications in Gansu Province among the Yugur, Baoan, and Dongxiang groups. The publications (such as Zhou et al., 2011a; Zhou and Wang, 2019) show that his team is at Lanzhou University, located in the capital city of Gansu Province.

The linear regression models also identified that the Manchu and Gelao groups are two significant outliers. Both of them have large populations (UNC University Libraries, 2021), but with only one and no publication, respectively. This may be attributed to the situation that neither of them is unique to any province (UNC University Libraries, 2021). The Manchu group may be seen as acculturation. The current scholars may overlook the Manchu people's dietary practices because they have been fused with the Han main group since the foundation of the Qing Dynasty (A.D. 1644- A.D. 1912) (Liu and Zhang, 2007). The Gelao group may be attributed to a lack of funding as well as few local scholars. Although the culinary culture of the Gelao people is still unique (Zhu, 2013), the major residency region of the Gelao people is Guizhou Province (UNC University Libraries, 2021), one of the most underdeveloped regions (Liu, 2016) with only one of the 211-project top university among all provinces in China (Ministry of Education of People's Republic of China, 2005). Lacking funding and few local scholars may result in the lack of studies related to research questions of the Gelao group.

The Gaoshan group is another ethnic minority group that lacks existing publications related to the current research questions. The condition of the Gaoshan group is unique as Taiwan is the major habitat of the Gaoshan group (UNC University Libraries, 2021). Currently, the People's Republic of China (PRC) is the sole representative of China in the United Nations and declares Taiwan as a province of China (Embassy of the People's Republic of China, 2021). PRC divides the Indigenous peoples in Taiwan as the Gaoshan ethnic minority group (UNC University Libraries, 2021). However, Taiwan has its independent government (Minister of Foreign Affairs, the Republic of China, 2021) and divides Indigenous peoples in Taiwan into different Indigenous tribes, including "Amis, Atayal, Paiwan, Bunun, Puyuma, Rukai, Tsou, Saisiyat, Yami, Tsao, Kavalan, Taroko, and any other tribes" (Council of Indigenous Peoples, 2021). Scholars from the Chinese mainland rarely go to Taiwan for research about nutrition and diet as they are required to have a Taiwan pass and endorsement (National Immigration Administration, 2019), whereas Taiwan scholars may not use the Gaoshan group for ethnic classification when conducting research. Several publications use the Taiwanese ethnic classification to document the nutrition status or dietary practices, such as the diet and nutrition study of Tsou Indigenous people in Taiwan (Huang, 2000). This may be the reason why no existing publications related to the nutrition status and dietary practices among the Gaoshan ethnic minority group. Therefore, when conducting a study related to Indigenous peoples in Taiwan, appropriate terms should be utilized when searching the literature. It is also important to evaluate why Taiwan categorizes Indigenous peoples in its way and consider whether it is valuable for the China mainland (PRC) to learn from this knowledge. According to the Center for World Indigenous Studies (Hinden, 2021), the lack of recognition of Indigenous peoples in China is because of tension between the construct of the Han group identity and western Indigeneity.

Only one publication specifies the branch of the ethnic minority group, Kunge people of the Blang group (Chan et al., 2019). It is essential to specify the location and branch of the study population as belonging to the same ethnic minority group can have different lifestyles and worldviews, which may affect nutrition status and dietary practices. For example, the Wa group in Yunnan Province has three branches with huge cultural differences, including the languages used in each branch (Gao, 2016).

The Chinese government has adopted multiple national policies to improve nutrition and health for the general Chinese population. This includes National Strategy for Healthy China, "Healthy China 2030" Planning Outline, National Nutrition Plan (2017–2030), China's Child Development Program (2011–2020), China's Rural Poverty Alleviation and Development Program (2011–2020), and Healthy China Action (2019–2030). Ethnic minority groups are included under these policies and even prioritized in several of them such as poverty alleviation programs (Zhang, 2013). Despite this, only a few studies consider factors of the traditional food systems of ethnic minority groups. This may be attributed to a lack of awareness and funding of traditional food systems of ethnic minority groups. As a result, several key studies easily influence the number of existing publications for each ethnic minority group. For example, Li and Hu (2015) study on exclusive breastfeeding rates leads exclusive breastfeeding to become the most widely distributed topic among ethnic minority groups for dietary habits; there are 15 ethnic minority groups who have exclusive breastfeeding data associated with this study. The studies on the Yugur group have six regional-level publications all led by the Lanzhou University (such as Zhou and Wang, 2018, 2019).

Therefore, more studies involving traditional food systems should be implemented in China because the diets of Chinese ethnic minority groups are affected by the influence of regions, environment, economic development, and religions (Zhai et al., 2007). Studies in other parts of the world have shown that many other factors in traditional food systems can affect the diet and nutrition of Indigenous peoples; the key factors include environment, cultural preference, affordability, health belief, education, and social media (Kuhnlein and Receveur, 1996). These factors may also affect the diet and nutrition of Chinese ethnic minority groups. Although existing publications have shown the utilization of traditional foods for either a specific ethnic minority group [such as the Blang group (Jiang et al., 2011) and the Tibetan group (Dickerson et al., 2008; Boesi,

2014)] or a specific region [such as Yunnan Province (Zhou et al., 2012)], no publication targets analysis of how traditional food systems affect nutrition and diet of ethnic minority groups from a broad perspective. Identifying traditional food systems can also help to improve nutrition status and dietary practices. For example, advocating local micronutrient-rich food to address micronutrient deficiency, introducing nutrition education based on local dietary habits to improve nutrition knowledge, and encouraging local plant cultivation to increase access to traditional foods (Caicedo and Chaparro, 2013).

Primary and middle school students are the main age groups for selected publications. This may be attributed to the convenience and cooperation of schools for research. Only studies on the Uygur group report maternal nutrition during pregnancy. Maternal nutrition will affect both the health of mothers and children (O'Toole et al., 2003; Schwarzenberg and Georgieff, 2018). Therefore, it is essential to implement more studies in maternal nutrition.

There are five limitations to this review. First, the current review does not include the analysis of risk factors or interventions concerning nutrition status or dietary practices of the ethnic minority groups in China as research questions, especially considering 20 and 12 publications are identified, respectively. Analyzing risk factors of malnutrition or dietary intake and nutrition interventions may inform the design and implementation of nutrition and dietary interventions. Thus, it is necessary to include the analysis of risk factors or interventions regarding nutrition status or dietary practices of ethnic minority groups in future studies. Second, there are multiple publications in Chinese related to ethnic minority food cultures (such as Ma, 1999; Kong, 2005; Fang, 2007; Zhao, 2007; Cai and Situ, 2008; and more). However, these publications focus more on anthropological and cultural issues without connecting to health, dietary intake, and/or nutrition in Indigenous cultures. Therefore, they were excluded but are worth examining for future interdisciplinary study designs. Third, contradictions exist in the results of nutrition status or dietary practices within an ethnic minority group. However, multiple factors, such as family size, education (Qu et al., 2013), income, and geographical factors (Wang C. et al., 2013), may contribute to the inconsistency of nutrition status and dietary practices because of the long time period. Fourth, Taiwan categorizes Indigenous peoples in a different manner than the China mainland. Therefore, when searching for literature on Indigenous peoples in Taiwan, it is imperative to use the appropriate terminology (i.e., tribal names) to find the most appropriate studies. Future research should evaluate why Taiwan categorizes Indigenous peoples in this way and consider whether it is valuable for China mainland (PRC) to also change their terminology and categorization. According to the Center for World Indigenous Studies (Hinden, 2021), the lack of recognition of Indigenous peoples in China is because of tension between the construct of traditional Han identity and western Indigeneity. Finally, the current review used undernutrition and overnutrition to represent the nutrition status of the ethnic minority groups. The definitions of undernutrition and overnutrition may not be the same and may not be the global criteria for under- and over-nutrition (Guo et al., 2016). Despite this, the current review reflects the nutrition status and dietary practices of the ethnic minority groups in China over the past 10 years.

CONCLUSION

This scoping review is the first study to target all 55 ethnic minority groups in China regarding their nutrition status and dietary practices. Through a review of 111 selected publications, the study shows that ethnic minority groups in China are suffering double-burden malnutrition and consuming an unbalanced diet but still have a better nutrition status than the Han main group in 2010. Multiple factors such as regional economic development, genetic differences, different diets, and physical activities may explain this phenomenon rather than just ethnicity inequality. Studies and publications are distributed unevenly among different regions and ethnic minority groups, and it may be attributed to funding availability, the convenience of studies, lack of awareness and policies, and the uniqueness of a specific ethnic minority group. More country-level programs and policies are necessary to address malnutrition and unbalanced diets at the country level. There is a dire need for more timely reports, research on traditional food systems and dietary intake, different age groups including maternal nutrition, the ethnic minority groups (Indigenous people in China), interdisciplinary perspectives and approaches, and specifying branches of the ethnic minority groups to better understand and address malnutrition and unbalanced diets among the ethnic minority groups (Indigenous peoples) in China.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

ZW contributed to the overall design, literature review, and writing about the current manuscript and was instructed and revised by AM-P. Both authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2022.867848/full#supplementary-material

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