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MINIREVIEWS

Potential risk factors for constipation in the community

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Abstract

Constipation is a common community health problem. There are many factors that are widely thought to be associated with constipation but real-world evidence of these associations is difficult to locate. These potential risk factors may be categorised as demographic, lifestyle and health-related factors. This review presents the available evidence for each factor by an assessment of quantitative data from cross-sectional studies of community-dwelling adults published over the last 30 years. It appears that there is evidence of an association between constipation and female gender, residential location, physical activity and some health-related factors such as self-rated health, some surgery, certain medical conditions and certain medications. The available evidence for most other factors is either conflicting or insufficient. Therefore, further research is necessary to determine if each factor is truly associated with constipation and whether it can be regarded as a potential risk factor. It is recommended that studies investigating a broad range of factors are conducted in populations in community settings. Multivariate analyses should be performed to account for all possible confounding factors. In this way, valuable evidence can be accumulated for a better understanding of potential risk factors for constipation in the community.

Key Words: Adults; Constipation; Epidemiology; Factors; Community

Core Tip: Despite widespread beliefs that there are a number of potential risk factors for constipation in the community, this review highlights the paucity of real-world evidence for most factors. It is unclear whether most factors are associated with constipation because, apart from female gender, physical activity, residential location and some health-related factors, there is insufficient evidence or conflicting data available. Further research is required in community-dwelling adult populations to

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understand the importance of each potential risk factor in constipation. A broad range of factors should be investigated in same population samples using multivariate analysis to determine which factors are truly associated with constipation in the community.

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INTRODUCTION

One of the most common health problems faced by the community is constipation[1]. In general, constipation can be defined as a lack of satisfactory defecation[1] which incorporates various symptoms and may be either chronic or sporadic. Chronic constipation is usually defined by a set of clinical symptoms known as the Rome criteria[2]; the Rome criteria have been revised several times following their introduction as Rome I criteria in 1994. Any constipation may be defined as constipation which includes both chronic and sporadic constipation[3]; this condition is generally self-reported in epidemiological studies.

A number of factors are widely considered to be associated with constipation however real-world evidence of these associations appears to be sparse[4,5]. It is widely accepted that prime risk factors for constipation in the community include low exercise levels, low fibre intake and inadequate fluid intake[6]. However, these risk factors have been challenged in the past due to a paucity of clinical evidence[4,5]. In addition to these factors, there are other determinants of health which are reported in the literature to be associated with constipation. These include lifestyle and demographic factors[7]. Furthermore, medications and medical conditions are well established as two major secondary causes of constipation[8,9].

Since there appears to be questionable real-world evidence for these various risk factors despite their wide acceptance in the community, this literature review seeks to assess each potential risk factor by reviewing evidence from population-based studies of community-dwelling adult populations. The specific aims of this review were to identify demographic, lifestyle and health-related factors reported to be associated with constipation and evaluate the evidence for each factor.

SEARCH STRATEGY

A search of relevant published literature was performed using the Ovid interface to MEDLINE and Embase electronic databases. In addition, some articles were located in PubMed. The "ancestry approach"[10] was also used to locate pertinent studies by searching references of selected articles.

The search was filtered to include only English language articles and population-based studies. Index search terms in various combinations were applied using the three main Boolean operators – AND, OR and NOT, and included: "constipation", "adults", "gastrointestinal disorders", "prevalence", "epidemiology", "factors" and "risk factors". Articles meeting the inclusion criteria were classified into chronic constipation and any constipation according to the definition of constipation used in the study. Because of the large number of articles published on these topics, the search was limited to articles which were published between 1989 and 2019.

Retrieved articles that were eligible for inclusion included peer-reviewed research articles, as well as systematic reviews, describing epidemiological studies in community settings. Articles reporting constipation relating to irritable bowel syndrome, opioid-induced constipation in cancer, faecal incontinence, bowel cleansing, constipation in infants and children, constipation in palliative care patients, constipation in hospital in-patients and constipation in residential care facilities were deemed inappropriate for this review and were excluded from the final literature review sample. Articles describing specific subpopulations such as those relating to university students, older adult populations (50 years of age and older), female

populations and male populations were excluded. Since the focus for this review was population-based studies, surveys where the sample size was fewer than 100 participants were also excluded.

Articles meeting the preliminary inclusion criteria were further screened. Articles were excluded when found to report results from employee groups[11-14], patient groups[15-19], and medical database records[20,21] as these were deemed not to be community settings. Self-reported constipation incorporates many and varied symptoms[22,23] and chronic constipation, as defined by Rome criteria, incorporates all possible symptoms of chronic constipation[2]; therefore, articles reporting only one symptom such as stool consistency or bowel motion frequency rather than constipation per se were not included in the final sample[24-31]. Also excluded were articles where the adult population sample was found to include participants below the age of 15 years[32-35].

In some articles there were sufficient data available to enable calculation of results for potential risk factors even though these results were not published; these included calculations of prevalence percentages and gender ratios. Any calculated data are clearly marked as such in the tables. However, in some epidemiological studies of general populations, the results reporting potential risk factors have been reported by gender only and it was not possible to amalgamate the data for inclusion of several factors in this review.

RESULTS

A final sample comprising 53 articles was selected for inclusion in this literature review. Of these, 9 were systematic reviews and 44 were quantitative epidemiological studies of community-based general adult populations. Three systematic reviews were international[7,36,37], two related to specific regions – North America[38] and Europe plus Oceania[39], and two related to specific countries – Iran[40] and China[41]. Another two reviews related to specific factors – co-morbidities and haemorrhoids[42,43]. The epidemiological studies were all cross-sectional surveys of adults residing in the community.

Factors potentially associated with constipation which emanated from our review included demographic factors (age, gender, income, education, work status and geography), lifestyle factors and behaviours (physical activity, smoking, and fibre, fluid, alcohol and coffee intakes) and numerous health-related factors (including medical conditions and medications). Each of these factors are discussed in turn.

DEMOGRAPHIC AND SOCIOECONOMIC FACTORS

The following section describes demographic and socioeconomic factors potentially associated with constipation in adults in community settings.

Age

For both chronic constipation and any constipation, it seems that there is not a clear association with age since conflicting results have been reported (Table 1)[44-63]. There may be a higher prevalence of constipation in older age groups as reported in some literature reviews and epidemiological studies. However, other studies reported either no such association or a higher prevalence of constipation in younger age groups.

For chronic constipation, one systematic review[36] found no significant differences in prevalence between younger and older age groups whereas reviews of Chinese[41] and Iranian[40] studies indicated an increased prevalence with age. Six epidemiological studies indicated higher prevalence of chronic constipation in younger age groups[44-49], whilst higher prevalence in older age groups was only reported in four studies[50-53]. Furthermore, in establishing an association between chronic constipation and age groups, four other studies did not demonstrate any trends[54-57].

For any constipation (chronic and sporadic), one systematic review[7] found an increased prevalence of any constipation after the age of 60 years with the largest increase in prevalence experienced after 70 years. Trends of increasing prevalence with increasing age were observed in three reviews[37,40,41], but one review of North American studies[38] concluded that the relationship between age and any constipation could not be established. An increase in any constipation with increasing

Table 1 Age and constipation

Ref.	Location	Sample size	Definition of constipation	Age range (yr)	Prevalence (%)	Odds ratio (95%CI)	*P* value
Harari *et al*[62], 1989	United States	42375	Self-report (12 mo)	< 40; 40-49; 50-59; 60-69; 70-79; > 80	2.6; 2.6; 2.9; 4.1; 5.5; 10.0	1.00; 1.00 (0.84, 1.18); 1.11 (0.92, 1.33); 1.60 (1.36, 1.86); 2.11 (1.80, 2.46); 3.80 (3.22, 4.49)	NR
Drossman *et al*[44], 1993	United States	5430	Rome I	15-34; 35-49; > 45	3.8; 3.6; 3.5	NR	NR
Talley *et al*[49], 1993	United States	690	Rome I	30-39; 60-64	25; 15	NR	< 0.05
Pare *et al*[45], 2001	Canada	1149	Self-report (3 mo)	18-34; 35-49; 50-64; > 65	26.4; 28.4; 26.3; 27.4	NR	NR
Pare *et al*[45], 2001	Canada	1149	Rome I	18-34; 35-49; 50-64; > 65	20.3; 14.5; 15.1; 15.4	NR	NR
Pare *et al*[45], 2001	Canada	1149	Rome II	18-34; 35-49; 50-64; > 65	16.1; 12.9; 14.8; 16.7	NR	NR
Choung *et al*[63], 2006	United States	3022	Self-report (12 mo)	< 50; > 50	1.32[1]; 7.87[1]	NR	NR
Wald *et al*[61], 2008	United States	2000	Self-report (12 mo)	< 29; 30-44; 45-59; > 60	13.4[1]; 19.1[1] 17.5[1]; 19.9[1]	NR	NR
Chang *et al*[46], 2007	United States	523	Rome III	< 50; > 50	18.2; 17.3	1.0; 0.94 (0.60, 1.48)	NR
Meinds *et al*[47], 2017	Netherlands	1259	Rome III	18-34; 35-46; 47-55; 56-64; 65-85	36.3; 26.6; 19.0; 19.2; 19.8	NR	< 0.001
Garrigues *et al*[60], 2004	Spain	349	Self-report (12 mo)	18-30; 31-50; 51-65	29.2; 29.2; 30.7	NR	NS
Fosnes *et al*[54], 2011	Norway	4622	Rome II	NR	NR	1.01 (1.003, 1.02)	0.005
Rey *et al*[55], 2014	Spain	1500	Rome III	18-40; 41-65; > 65	19; 19; 20	NR	
Ebling *et al*[50], 2014	Croatia	658	Rome III	20-34; 35-49; 50-69	16.2; 22.7; 26.2	NR	0.035; 0.182
Papatheodoridis *et al*[51], 2010	Greece	1000	Rome III or self-report (12 mo)	15-29; 30-44; 45-59; 60-64	12; 16; 18; 25	0.422 (0.226, 0.788); 0.721 (0.397, 1.310); 0.670 (0.362, 1.241); 1.0	0.007; 0.283; 0.203; 0.010
Wald *et al*[61], 2008	United Kingdom	2000	Self-report (12 mo)	< 29; 30-44; 45-59; > 60	5.9[1]; 7.7[1]; 8.1[1]; 9.1[1]	NR	NR
Wald *et al*[61], 2008	France	2000	Self-report (12 mo)	< 29; 30-44; 45-59; > 60	12.2[1]; 12.4[1]; 9.4[1]; 22.0[1]	NR	NR
Wald *et al*[61], 2008	Germany	2000	Self-report (12 mo)	< 29; 30-44; 45-59; > 60	1.5[1]; 4.3[1]; 5.5[1]; 8.7[1]	NR	NR
Wald *et al*[61], 2008	Italy	2000	Self-report (12 mo)	< 29; 30-44; 45-59; > 60	5.8[1]; 6.9[1]; 8.9[1] 10.6[1]	NR	NR
Wald *et al*[59], 2010	China	2100	Self-report (12 mo)	< 29; 30-44; 45-59	12.7[1]; 16.0[1]; 18.6[1]	NR	NR
Wald *et al*[59], 2010	Indonesia	2000	Self-report (12 mo)	< 29; 30-44; 45-59; > 60;	11.6[1]; 13.5[1]; 15.3[1]; 9.6[1]	NR	NR
Wald *et al*[59], 2010	South Korea	2000	Self-report (12 mo)	< 29; 30-44; 45-59; > 60;	18.1[1]; 15.6[1]; 16.9[1]; 14.1[1]	NR	NR
Jun *et al*[58], 2006	South Korea	1029	Self-report (3 mo)	15-19; 20-29; 30-39; 40-49; 50-59; > 60	22; 22; 15; 15; 14; 12	NR	0.003
Cheng *et al*[57], 2003	Hong Kong	3282	Rome II	< 30; 30-39; 40-49; 50-59; > 59	14.5; 13.6; 11.8; 13.7; 14.9	NR	NR
Lu *et al*[56], 2006	Taiwan	2018	Rome II	20-29; 30-39; 40-49; 50-59; 60-69; 70-79	12.2; 7.9; 7.4; 7.1; 10.4; 11.9	NR	0.04
Sorouri *et al*[53],	Iran	18180	Rome III	< 40; 40-60; >	1.4; 4.7; 4.9	1.01 (1, 1.01)	< 0.05

2010				60			
Moezi *et al*[52], 2018	Iran	9264	Rome IV	40-59; > 60	6.9[1]; 11.9[1]	1.55 (1.31, 1.83)	< 0.001
Wald *et al*[59], 2010	Argentina	2000	Self-report (12 mo)	< 29; 30-44; 45-59; > 60	11.6[1]; 12.3[1]; 17.1[1]; 17.3[1]	NR	NR
Wald *et al*[59], 2010	Colombia	2000	Self-report; (12 mo)	< 29; 30-44; 45-59; > 60	19.6[1]; 25.6[1]; 25.3[1]; 25.5[1]	NR	NR
Wald *et al*[59], 2010	Brazil	2000	Self-report (12 mo)	< 29; 30-44; 45-59; > 60	13.9[1]; 17.3[1]; 19.4[1]; 19.0[1]	NR	NR
Howell *et al*[48], 2006	Sydney	1673	Rome II	25-34; 35-44; 45-54; 55-64	37.8; 27.7; 27.4; 27.6	NR	0.03

[1]Calculated from data published. NR: Not reported; NS: Not significant.

age has been reported in epidemiological studies from various countries[58-61]; however, the prevalence of any constipation decreased with increasing age in studies elsewhere[58,59] (Table 1). In other epidemiological studies, no clear association of age and any constipation was seen[45,59-61].

Female gender

The prevalence of constipation is consistently higher in females compared to males in all systematic reviews and almost all epidemiological studies included in this review (Table 2)[22,23,45-81]. Most studies reporting gender differences have used female/male (F/M) ratios to express the result with only a few studies reporting odds ratios. Based on these data, it would appear that females are approximately twice as likely as males to report chronic constipation and more than twice as likely to report any constipation.

For chronic constipation, systematic reviews have reported mean F/M ratios of 1.4[41], 1.89[36] and 1.75[38,39]. Similar ratios are also seen in most epidemiological studies where F/M ratios have ranged from 1 to 10 in 24 studies conducted in various countries (Table 2). Only one study has shown a greater prevalence in males where the F/M ratio was 0.84[50]. Odds ratios for chronic constipation in females were reported as 2.22 in a global systematic review[36] and ranged from 1.0 to 4.8 in epidemiological studies[46,47,51,53,54,60,64-66].

For any constipation, systematic reviews have reported mean F/M ratios ranging from 2.1. to 2.65[7,38,39]. In 26 epidemiological studies, F/M ratios have ranged from 1.10 to 6.75 across 17 countries (Table 2). In 8 of these studies the difference between genders was reported to be statistically significant ($P < 0.05$). Odds ratios for any constipation in females ranged from 2.0 to 3.8 in systematic reviews[37,38] and epidemiological studies[59-61,67].

Income level

It is not clear from this literature review whether constipation and income are associated. The association of income level and constipation appears to vary by country but even within one country conflicting results have been reported (Table 3). In many countries, an inverse (negative) relationship has been found between constipation and income, with a higher prevalence of constipation with lower incomes.

For chronic constipation, a Canadian study showed evidence of an inverse relationship[45] but this was not the case in a United States study[68]. In Iran and Brazil, there was significantly higher prevalence in those with lower income[52,66] but there was no inverse relationship in South Korea[58] and Hong Kong[57]. An inverse relationship was also reported in an Australian study[82].

For any constipation, an inverse relationship was seen in the United Kingdom, Germany, Brazil, Colombia and China, but no such trend was evident in France, Italy, South Korea and Indonesia[59,61,75]. North American studies indicate that the prevalence of any constipation increases as income decreases[38,61].

Educational level

The association of educational level and constipation is not clear with studies in various countries showing mixed results (Table 4).

In studies of chronic constipation, there was evidence of an inverse relationship, *i.e.*, higher prevalence of constipation in those with lower levels of education, in United States, Chinese, Croatian and Iranian studies[41,49,50,52,53,83] but in other studies,

Table 2 Gender and constipation

Ref.	Location	Sample size	Age range (yr)	Definition of constipation	Prev. males (%)	Prev. females (%)	F/M ratio	Odds ratio (95%CI)	*P* value
Everhart *et al*[67], 1989	United States	11204	25-74	Self-report (NTP)	3.6	11.4	3.17[1]	3.8 (2.6, 5.6)	NR
Talley *et al*[64], 1991	United States	835	30-64	Rome I	13.9	20.8	1.50[1]	1.6 (1.1, 2.3)	NR
Talley *et al*[49], 1993	United States	690	30-64	Self-reportRome I	2.7; 18.3	7.3; 20.1	2.70[1]; 1.01[1]	NR	NR
Drossman *et al*[44], 1993	United States	5430	> 15	Rome I	2.4	4.8	2.00[1]	1.99 (1.5, 2.7)	NR
Stewart *et al*[68], 1999	United States	10018	> 18	Rome II	12.0	16.0	1.33[1]	NR	NR
Pare *et al*[45], 2001	Canada	1149	> 18	Self-report (3 mo)	18.4	35.4	1.92[1]	NR	NR
Pare *et al*[45], 2001	Canada	1149	> 18	Rome I	12.0	21.0	1.75[1]	NR	NR
Pare *et al*[45], 2001	Canada	1149	> 18	Rome II	8.3	21.1	2.54[1]	NR	NR
Choung *et al*[63], 2006	United States	2718	20-95	Self-report (12 mo)	2.76[1]	6.44[1]	2.33[1]	NR	NR
Chang *et al*[46], 2007	United States	523	30-64	Rome III	17.8	17.8	1.00	1.0 (0.64, 1.57)	NR
Wald *et al*[61], 2008	United States	2000	> 15	Self-report (12 mo)	13.6	21.4	1.57	NR	NR
Choung *et al*[65], 2012	United States	2853	> 20	Rome II	20.1[1]	27.7[1]	1.38[1]	1.6 (1.3, 1.9)	< 0.01
Choung *et al*[69], 2016	United States	2327	> 25	Rome III (mod)	5.1	8.7	1.71[1]	NR	NR
Meinds *et al*[47], 2017	Netherlands	1259	> 18	Rome III	18.8	29.3	1.56[1]	1.8 (1.4, 2.3)	< 0.001
Van Kerkhoven *et al*[70], 2008	Netherlands	1616	> 18	Self-report (4 wk)	7	18	2.57[1]	NR	< 0.01
Garrigues *et al*[60], 2004	Spain	349	18-65	Self-report (12 mo)	18.0	40.1	2.23[1]	2.9 (1.68, 4.98)	0.0001
Garrigues *et al*[60], 2004	Spain	349	18-65	Rome II	5.5	22.0	4.0[1]	4.58 (1.98, 10.60)	0.0004
Walter *et al*[22], 2002	Sweden	1610	31-76	Self-report (NTP)	8.3	19.8	2.39[1]	NR	< 0.0001
Haug *et al*[71], 2002	Norway	62651	> 20	Self-report (12 mo)	1.5	5.7	3.8[1]	NR	< 0.05
Fosnes *et al*[54], 2011	Norway	4622	31-76	Rome II	6.7[1]	19.3[1]	2.88[1]	3.24 (2.61, 4.02)	< 0.001
Gaburri *et al*[72], 1989	Italy	519	NR	Self-report (3 yr)	1.2[1]	8.1[1]	6.75[1]	NR	NR
Heaton *et al*[73], 1993	United Kingdom	1892	26-69	Self-report (NTP)	14.7	31.1	2.12[1]	NR	< 0.001
Wald *et al*[61], 2008	United Kingdom	2000	> 15	Self-report (12 mo)	4.2	10.9	2.60	NR	NR
Wald *et al*[61], 2008	Germany	2000	> 15	Self-report (12 mo)	3.0	7.5	2.5	NR	NR
Wald *et al*[61], 2008	Italy	2000	> 15	Self-report (12 mo)	4.9	10.8	2.2	NR	NR
Wald *et al*[61], 2008	France	2000	> 15	Self-report (12 mo)	8.6	18.9	2.2	NR	NR
Rey *et al*[55], 2014	Spain	1500	> 18	Rome III	10.6	27.6	2.7	NR	NR
Esteban y Peña *et al*[74], 2014	Spain	7341	> 16	Self-report (NTP)	1.9	5.9	3.1[1]	NR	< 0.001
Enck *et al*[75], 2016	Germany	15002	> 18	Self-report (12 mo)	NR	NR	2.3	NR	NR
Ebling *et al*[50], 2014	Croatia	658	20-70	Rome III	24.3	20.3	0.84[1]	NR	0.2260.126
Papatheodoridis *et al*[51], 2010	Greece	1000	15-64	Rome III or self-report (12 mo)	11	21	1.91[1]	2.10 (1.41, 3.12)	< 0.001
Wald *et al*[61], 2008	Brazil	2000	> 15	Self-report	8.5	24.2	2.85	NR	NR
Wald *et al*[59], 2010	Argentina	2000	> 15	Self-report	7.9	20.2	2.56	NR	NR

Wald *et al*[59], 2010	Colombia	2000	> 15	Self-report	14.7	28.3	1.93	NR	NR
Schmidt *et al*[66], 2016	Brazil	2162	> 18	Rome III	5.3	21.9	4.13[1]	4.3 (3.1, 6.1)	NR
Ho *et al*[76], 1998	Singapore	706	21-95	Rome II	2.8	5.6	2.0[1]	NR	NR
Chen *et al*[77], 2000	Singapore	271	> 16	Rome II	3.6	11.3	3.14[1]	NR	< 0.05
Cheng *et al*[57], 2003	Hong Kong	3282	18-80	Rome II	13.9	14.5	1.04[1]	NR	NR
Lu *et al*[56], 2006	Taiwan	2018	> 20	Rome II	7.0[1]	10.6[1]	1.51[1]	NR	< 0.001
Chang *et al*[78], 2012	Taiwan	4275	> 19	Rome III	2.8	6.2	2.21[1]	NR	0.001
Jun *et al*[58], 2006	South Korea	1029	> 15	Self-report (3 mo)	10.4	22.8	2.19[1]	NR	< 0.001
Jeong *et al*[79], 2008	South Korea	1417	18-69	Rome II	0.5	5.0	10.0[1]	NR	< 0.05
Wald *et al*[61], 2008	South Korea	2000	> 15	Self-report (12 mo)	10.7	22.7	2.12	NR	NR
Tamura *et al*[23], 2016	Japan	5155	20-79	Self-report (NTP)	19.1	37.5	1.96[1]	NR	< 0.001
Wald *et al*[59], 2010	Indonesia	2000	> 15	Self-report (12 mo)	10.7	15.1	1.41	NR	NR
Wald *et al*[59], 2010	China	2100	15-60	Self-report (12 mo)	10.8	19.7	1.82	NR	NR
Sorouri *et al*[53], 2010	Iran	18180	NR	Rome III	1.2	3.7	3.08[1]	1.83 (1.44, 2.32)	< 0.01
Moezi *et al*[52], 2018	Iran	9264	40-75	Rome IV	6.7	9.3	1.44	NR	< 0.001
Talley *et al*[80], 1998	Australia	730	> 18	BSQ	6.3	21.1	3.35	NR	NR
Howell *et al*[48], 2006	Australia	1673	25-64	Rome II	25.1	36.0	1.43	NR	NR
Koloski *et al*[81], 2015	Australia	3260	> 18	Rome III	3.25[1]	8.95[1]	2.75[1]	NR	NR

[1]Calculated from published data. Prev.: Prevalence; F/M: Female/Male; Mod: Modified; NR: Not reported; NS: Not significant; NTP: No time period specified; BSQ: Bowel symptom questionnaire (similar to Rome criteria).

there was no clear evidence of this or any other trend[45,46,51,55,57,65,68].

Most North American studies[38,45,61,67] have shown an inverse relationship between prevalence of any constipation and years of education. In studies of any constipation in other countries, both trends were observed; in the United Kingdom, France, Germany, Italy and South Korea[61,75], there was an inverse relationship between any constipation and educational level but the opposite was found in Brazil, China and Indonesia[59,61]. No trends were found in Spain, Argentina and Colombia[59,60].

Residential region within countries

The prevalence of constipation appears to vary by residential region within some countries (Table 5). Significant differences in the prevalence of any constipation have been observed in China between different regions and between rural and urban locations, with a significantly higher prevalence in rural areas[41]. However, in Croatia there was a significantly higher prevalence of chronic constipation in urban populations[50]. Regional differences have also been reported for any constipation in Canada and Greece[45,51] and in Spain for chronic constipation[55].

Other demographic and socioeconomic factors

The association of work or employment status and constipation is not clear with studies in various countries showing mixed results (Table 6). In Germany, there appears to be an increased prevalence of any constipation in those not working[75] but in North America chronic constipation seems to be more prevalent in those working[45,49].

Similarly, the association of marital status and constipation is not clear but there may be a tendency for a lower prevalence of chronic constipation in those who are married (Table 6).

One United States study has shown a lower prevalence of chronic constipation in white participants compared to other ethnic groups[44]. Ethnicity differences have also been reported in China[41].

Table 3 Income level and constipation

Ref.	Location	Sample size	Age range (yr)	Definition of constipation	Income/year or week	Prevalence (%)	Odds ratio (95%CI)	*P* value
Stewart *et al*[68], 1999	United States	10018	> 18	Rome II	< $20000; $20-29900; $30-49900; > $50000	NR	1; 0.90; 1.10; 1.02	NR
Pare *et al*[45], 2001	Canada	1149	> 18	Self-report (3 mo)	< $20000; $20-39900; $40-59900; $60-79900; > $80000	33.8; 23.7; 24.3; 28.0; 21.8	1.55; 1.01; 1.11; 1.28; 1	NR
Pare *et al*[45], 2001	Canada	1149	> 18	Rome I	< $20000; $20-39900; $40-59900; $60-79900; > $80000	18.5; 16.3; 17.6; 13.1; 12.1	1.53; 1.35; 1.45; 1.08; 1	NR
Pare *et al*[45], 2001	Canada	1149	> 18	Rome II	< $20000; $20-39900; $40-59900; $60-79900; > $80000	15.3; 14.3; 13.9; 14.5; 8.3	1.84; 1.72; 1.67; 1.75; 1	NR
Wald *et al*[61], 2008	United States	2000	> 15	Self-report (12 mo)	Low; Middle; High	20.9; 16.1; 16.8	NR	NR
Wald *et al*[61], 2008	United Kingdom	2000	> 15	Self-report (12 mo)	Low; Middle;High	8.8; 7.27.1	NR	NR
Wald *et al*[61], 2008	France	2000	> 15	Self-report (12 mo)	Low; Middle; High	14.9; 11.3; 15.8	NR	NR
Wald *et al*[61], 2008	Germany	2000	> 15	Self-report (12 mo)	Low; Middle; High	7.2; 3.6; 5.3	NR	NR
Enck *et al*[75], 2016	Germany	15002	> 18	Self-report (12 mo)	< 1000; 1000-1500; 1500-2000; 2000-2500; 2500-3000; 3000-4000; > 4000	19.0[1]; 18.8[1]; 14.6[1]; 13.6[1]; 13.3[1]; 11.3[1]; 11.5[1]	NR	< 0.001
Wald *et al*[61], 2008	Italy	2000	> 15	Self-report (12 mo)	Low; Middle; High	7.8; 7.0; 8.4	NR	NR
Wald *et al*[61], 2008	Brazil	2000	> 15	Self-report (12 mo)	Low; Middle; High	17.9; 15.8; 14.2	NR	NR
Schmidt *et al*[66], 2016	Brazil	2162	> 18	Rome III	2-15; 1.5-2; 1-1.5; 0.5-1; 0-0.5	11.1; 9.7; 13.8; 15.4; 21.8	1.0; 0.8 (0.5, 1.4); 1.3 (0.8, 2.1); 1.4 (0.9, 2.2); 1.9 (1.2, 3.0)	NR
Wald *et al*[61], 2008	South Korea	2000	> 15	Self-report (12 mo)	Low; Middle; High	17.1; 15.7; 17.1	NR	NR
Wald *et al*[59], 2010	Colombia	2000	> 15	Self-report (12 mo)	Low; Middle; High	23.9; 20.3; 14.8	NR	NR
Wald *et al*[59], 2010	China	2100	15-60	Self-report (12 mo)	Low; Middle; High	16.2; 15.5; 13.2	NR	NR
Wald *et al*[59], 2010	Indonesia	2000	> 15	Self-report (12 mo)	Low; Middle; High	13.1; 12.2; 14.0	NR	NR
Moezi *et al*[52], 2018	Iran	9264	40-75	Rome IV	Low; High	9.1; 6.5	NR	0.024
Cheng *et al*[57], 2003	Hong Kong	3282	18-80	Rome II	Nil; < 10000; 10000-19999; 20000-29999; 30000-39999; 40000-49999; > 50000	13.6; 14.8; 12.5; 12.6; 12.5; 12.5; 13.1	NR	NR
Jun *et al*[58], 2006	South Korea	1029	> 15	Rome II	< 1000; 1010-2000; 2010-3000; 3010-4000; > 4010	16; 15; 20; 26; 24	NR	0.044

Bytzer *et al*[82], 2001	Australia	8185	> 18	Rome II	5th quintile (lowest); 4th quintile; 3rd quintile; 2nd quintile; 1st quintile (highest)	10.2; 10.3; 9.6; 8.7; 6.3	NR	NR

[1]Calculated from data published.

Note: Income is stated in various currencies. NR: Not reported; NS: Not significant.

LIFESTYLE AND BEHAVIOURAL FACTORS

The following section describes lifestyle and behavioural factors potentially associated with constipation in adults in community settings.

Physical activity

There is limited evidence that low levels of physical activity and physical inactivity are associated with a high prevalence of constipation. Low levels of exercise/physical activity were significantly associated with increasing rates of both chronic[52,55] and any constipation[60,61] in studies conducted in various countries (Table 7).

Smoking

Conflicting data indicates that there is no clear association of smoking with the prevalence of chronic or any constipation (Table 8). United States and Iranian studies[52,83] have suggested that smoking may be a possible risk factor in chronic constipation. However other United States studies[46,65] and studies in Greece and Taiwan[51,56] found no significant differences in the prevalence of chronic constipation in smokers and non-smokers. Furthermore, one United States study[49] and one study in Norway[71] found that smoking was a negative risk factor for chronic and any constipation respectively.

Fibre

There is little evidence that low fibre intake is associated with a high prevalence of either chronic or any constipation (Table 9). In one Spanish study, both low and high fibre intakes were associated with increased prevalence of any constipation[60] and in another Spanish study there was no significant association with chronic constipation[55].

Fluid

There is little evidence that fluid intake is associated with the prevalence of chronic or any constipation (Table 10). The only evidence occurred in one Spanish study where chronic constipation was inversely related to fluid intake, defined as glasses of liquids consumed daily[55]. One United States study showed no association of coffee with chronic constipation[46].

Alcohol

There is limited evidence that alcohol consumption may be associated with a decreased prevalence of chronic constipation (Table 11).

Several studies have investigated the association of alcohol and chronic constipation. Increasing alcohol intake was a negative risk factor for chronic constipation in a United States study[49] and also in a Norwegian study[54]. A similar trend was observed in Taiwan[56] and other United States studies, but the opposite trend was found in Iran, but no relationships reached significance[46,52,56,83].

HEALTH-RELATED FACTORS

The following section describes health-related factors potentially associated with constipation in adults in community settings.

Self-rated health

Fair or poor self-rated health was significantly associated with an increased prevalence of chronic constipation in two European studies[50,75] (Table 12).

Table 4 Educational level and constipation

Ref.	Location	Sample size	Age range (yr)	Definition of constipation	Educational level	Prevalence (%)	Odds ratio (95%CI)	*P* value
Everhart *et al*[67], 1989	United States	11204	25-74	Self-report (NTP)	> 8 yr; 9-11 yr; > 12 yr	NR	2.78; 1.35; 1	NR
Talley *et al*[49], 1993	United States	690	30-64	Rome I	< HS; HS; > HS	23.3; 18.4; 18.0	NR	NR
Stewart *et al*[68], 1999	United States	10018	> 18	Rome II	< 12 yr; 12 yr; 13-15.9 yr; > 16 yr	NR	1; 1.49; 1.41; 1.39	NR
Pare *et al*[45], 2001	Canada	1149	> 18	Self-report (3 mo)	Grade school; Some HS; HS; Diploma; Tech school; Some college; College; Grad school	28.8; 35.1; 24.6; 29.4; 20.5; 25.4; 31.5; 19.6	NR	NR
Pare *et al*[45], 2001	Canada	1149	> 18	Rome I	Grade school; Some HS; HS; Diploma; Tech school; Some college; College; Grad school	14.3; 23.8; 18.8; 22.1; 15.0; 9.9; 17.2; 11.3	NR	NR
Pare *et al*[45], 2001	Canada	1149	> 18	Rome II	Grade school; Some HS; HS; Diploma; Tech school; Some college; College; Grad school	4.3; 21.7; 18.6; 18.4; 12.0; 8.6; 6.5; 10.0	NR	NR
Wald *et al*[61], 2008	United States	2000	> 15	Self-report (12 mo)	< Secondary; Secondary; Tertiary	24.7; 18.9; 15.4	1.82 (1.16, 2.86)	< 0.01
Choung *et al*[83], 2007	United States	3022	20-95	BDQ	< HS; HS/College; > College	NR	1.3 (0.5, 3.1); 1.0; 0.8 (0.5, 3.1)	NS
Chang *et al*[46], 2007	United States	523	30-64	Rome III	< HS; HS/College; > College	16.7; 19.8; 14.8	0.81 (0.27, 2.46);1.00; 0.70 (0.43, 1.14)	NR
Choung *et al*[65], 2012	United States	2853	> 20	Rome II	< HS; HS/College; > College	7.0; 26.5; 20.3	NR	0.002
Wald *et al*[61], 2008	United Kingdom	2000	> 15	Self-report (12 mo)	< Secondary; Secondary; Tertiary	9.4; 7.0; 7.3	NR	NR
Wald *et al*[61], 2008	France	2000	> 15	Self-report (12 mo)	< Secondary; Secondary; Tertiary	17.6; 13.0; 12.7	1.48 (1.01, 2.15)	< 0.05
Wald *et al*[61], 2008	Germany	2000	> 15	Self-report (12 mo)	< Secondary; Secondary; Tertiary	5.6; 5.5; 4.5	NR	NR
Enck *et al*[75], 2016	Germany		> 18	Self-report (12 mo)	< Secondary; Secondary; Tertiary	19.6; 15.3; 15.6	NR	< 0.001
Ebling *et al*[50], 2014	Croatia	658	20-69	Rome III	< Elementary; Elementary; High school; Bachelor; University	50.0; 25.6; 20.2; 23.0; 23.4	0.278; 0.229; 0.248; 0.383	0.065; 0.028; 0.060; 0.178
Wald *et al*[61], 2008	Italy	2000	> 15	Self-report (12 mo)	< Secondary; Secondary; Tertiary	8.0; 8.1; 6.0	NR	NR
Papatheodoridis *et al*[51], 2010	Greece	1000	15-64	Rome III or self-report (12 mo)	Primary or less; Secondary; Higher	18; 14; 17	NR	0.31
Rey *et al*[55], 2014	Spain	1500	> 18	Rome III	Primary Secondary; University	19; 18; 20	NR	NR
Garrigues *et al*[60], 2004	Spain	349	18-65	Self-report (12 mo)	Basic; Primary Secondary or more	31.4; 26.4; 30.3	NR	NS
Wald *et al*[59], 2010	Argentina	2000	> 15	Self-report (12 mo)	< Secondary; Secondary; Tertiary	15.1; 13.4; 14.8	NR	NR
Wald *et al*[59], 2010	Colombia	2000	> 15	Self-report (12 mo)	< Secondary; Secondary; Tertiary	25.2; 21.0; 24.5	NR	NR
Wald *et al*[59], 2010	Brazil	2000	> 15	Self-report (12 mo)	< Secondary; Secondary; Tertiary	17.0; 15.2; 26.5	0.58 (0.36, 0.92)	< 0.03
Wald *et al*[59],	China	2100	15-60	Self-report (12	< Secondary; Secondary;	10.2; 16.5; 14.4	NR	NR

2010				mo)	Tertiary			
Wald *et al*[59], 2010	Indonesia	2000	> 15	Self-report (12 mo)	< Secondary; Secondary; Tertiary	10.6; 13.2; 19.0	NR	NR
Wald *et al*[59], 2010	Korea	2000	> 15	Self-report (12 mo)	< Secondary; Secondary; Tertiary	18.1; 16.7; 16.0	NR	NR
Cheng *et al*[57], 2003	Hong Kong	3282	18-80	Rome II	Nil; Primary; Junior HS; HS; Matriculation; University	14.5; 12.2; 14.8; 12.6; 14.0; 14.1	NR	NR
Sorouri *et al*[53], 2010	Iran	18180	NR	Rome III	Illiterate; < Diploma; HS diploma; University; > Masters	2.9; 2.1; 2.5; 2.1; 1.6	NR	NR
Moezi *et al*[52], 2018	Iran	9264	40-75	Rome IV	Illiterate; Other	9.0; 7.2	NR	0.002
Howell *et al*[48], 2006	Australia	1673	25-64	Rome II	Low; Low-mid; Mid-upper; High	30.6; 31.6; 38.9; 25.1	1.50 (0.97, 2.31); 1.49 (1.02, 2.18); 1.91 (1.33, 2.73)1	0.07; 0.04; 0.001

[1]Calculated from published data.

HS: High school; BDQ: Bowel disease questionnaire (similar to Rome criteria); NR: Not reported; NS: Not significant.

Table 5 Residential region and constipation

Ref.	Location	Sample size	Age range (yr)	Definition of constipation	Region of residence	Prevalence (%)	Odds ratio (95%CI)	*P* value
Pare *et al*[45], 2000	Canada	1149	> 18	Self-report (3 mo)	Atlantic; Quebec; Ontario; Prairies; British Columbia	26.7; 25.8; 26.7; 25.6; 32.3	NR	NR
Pare *et al*[45], 2000	Canada	1149	> 18	Rome I	Atlantic; Quebec; Ontario; Prairies; British Columbia	18.2; 22.1; 13.5; 16.4; 14.5	NR	NR
Pare *et al*[45], 2000	Canada	1149	> 18	Rome II	Atlantic; Quebec; Ontario; Prairies; British Columbia	15.9; 18.6; 13.7; 14.0; 11.9	NR	NR
Papatheodoridis *et al*[51], 2010	Greece	1000	15-64	Rome III or self-report (12 mo)	Athens; Thessaloniki; Other cities	13; 18; 19	0.581 (0.399, 0.844); 0.928 (0.539, 1.598);1.0	0.004; 0.787; 0.017
Rey *et al*[55], 2014	Spain	1500	> 18	Rome III	Mediterranean; Centre; Atlantic	21; 17; 15	NR	NR
Rey *et al*[55], 2014	Spain	1500	> 18	Rome III	Urban; Rural	20; 18	NR	NR
Ebling *et al*[50], 2014	Croatia	658	20-69	Rome III	Urban; Rural	22.2; 17.5	1.947	0.003
Chu *et al*[41], 2014	China		> 18	Rome II	Hong Kong; Mainland	14.0; 6.4	NR	< 0.001
Chu *et al*[41], 2014	China		> 18	Rome II	North; South	15.5; 3.3	NR	< 0.001
Chu *et al*[41], 2014	China		> 18	Rome II	East; Midwest	4.0; 11.0	NR	< 0.001
Chu *et al*[41], 2014	China		> 18	Rome II	Urban; Rural	6.7; 7.2	NR	< 0.001

[1]Calculated from data published. NR: Not reported.

Medical conditions

Various medical conditions have been reported to be potentially associated with constipation in epidemiological studies (Table 13).

Gastrointestinal disorders: In a review of co-morbidities[42], dyspepsia, heartburn, gastroesophageal reflux disease (GORD) and nausea/vomiting were commonly associated with chronic constipation. The association of GORD with constipation has been reported in several epidemiological studies[41,52,65]. Other gastrointestinal disorders including colorectal cancer and diverticulitis have also been associated with any constipation[43] and chronic constipation[65,69].

Anorectal disorders, particularly haemorrhoids, are frequently associated with constipation. A review of 7 studies conducted up to 2009[43] found a significant association between any constipation and haemorrhoids. Haemorrhoids also have

Table 6 Other demographic/socioeconomic factors and constipation

Ref.	Location	Sample size	Age range (yr)	Definition of constipation	Factor	Variable	Prevalence (%)	Odds ratio (95%CI)	*P* value
Talley *et al*[49], 1993	United States	690	30-64	Self-report; Rome I	Marital status	Married; Not married	17.8; 22.1	NR	NR
Chang *et al*[46], 2007	United States	523	30-64	Rome III	Marital status	Married; Single; Other	17.2; 23.1; 19.1	1.0; 1.27 (0.46, 3.48); 1.07 (0.53, 2.16)	NS
Choung *et al*[83], 2007	United States	3022	20-95	BDQ	Marital status	Married; Not married	16; 22	0.8 (0.5, 1.2); 1.0	NS
Rey *et al*[55], 2014	Spain	1500	> 18	Rome III	Marital status	Married; Single; Other	20; 16; 22	NR	NR
Ebling *et al*[50], 2014	Croatia	658	20-69	Rome III	Marital status; House; hold size	Divorced; Large size	35.7; NR	2.91; 1.19	0.039; 0.01
Sorouri *et al*[53], 2010	Iran	18180	NR	Rome III	Marital status	Married; Single; Widowed; Divorced	3.5; 0.7; 8.8; 12.5	NR	NR
Moezi *et al*[52], 2018	Iran	9264	40-75	Rome IV	Marital status	Divorced or Widowed	12.9	NR	< 0.001
Pare *et al*[45], 2000	Canada	1149	> 18	Self-report (3 mo)	Work status	Employed; Unemployed; Retired	27.2; 23.4; 25.5	NR	NR
Pare *et al*[45], 2000	Canada	1149	> 18	Rome I	Work status	Employed; Unemployed; Retired	16.3; 9.2; 15.0	NR	NR
Pare *et al*[45], 2000	Canada	1149	> 18	Rome II	Work status	Employed; Unemployed; Retired	14.1; 5.7; 16.2	NR	NR
Talley *et al*[49], 1993	United States	690	30-64	Rome I	Work status	Employed; Unemployed	20.1; 12.0	NR	NR
Enck *et al*[75], 2016	Germany	15002	> 18	Self-report (12 mo)	Work status	Full-time; Part-time; Unemployed	10.8[1]; 13.3[1]; 18.3[1]	NR	< 0.001
Drossman *et al*[44], 1993	United States	5430	> 15	Rome I	Ethnicity	White; Other	NR	0.54 (0.3, 0.9)	NR

[1]Calculated from data published.

NR: Not reported; NS: Not significant; BDQ: Bowel disease questionnaire (similar to Rome criteria).

been found to be commonly associated with chronic constipation[41,66]. Other anorectal disorders found to be associated with any constipation include fistulas, anal fissures and rectal prolapse[43,66].

Depression, anxiety and insomnia: There is evidence that depression and anxiety are associated with chronic and any constipation, and limited evidence for insomnia.

In a review of comorbidities, depression was the most commonly reported psychiatric condition associated with chronic constipation, occurring in 15% to 29% of chronic constipation patients[42]. In other studies not included in the review, depression and anxiety were found to be significantly associated with both chronic or any constipation[52,57,71,84]; one of these studies also found insomnia to be significantly associated with chronic constipation[52].

Neurological diseases: Odds ratios for chronic constipation in multiple sclerosis have been reported to be 5.5[69] and 2.41[54] in two studies; chronic constipation in Parkinson's disease had an odds ratio of 6.5[69].

Obesity: There is conflicting evidence of any association of obesity or body weight with chronic or any constipation.

In a review of comorbidities, chronic constipation was frequently associated with obesity (20% to 37% of chronic constipation patients) and being overweight (17% to 40% of chronic constipation patients)[42]. However, other epidemiological studies

Table 7 Physical activity and constipation

Ref.	Location	Sample size	Age range (yr)	Definition of constipation	Physical activity status	Prevalence (%)	Odds ratio (95%CI)	*P* value
Garrigues *et al*[60], 2004	Spain	349	18-65	Self-report (12 mo)	Never; Sometimes; Habitually	23.2; 10.9; 7.4	1.00; 0.43 (0.20, 0.89); 0.31 (0.11, 0.87)	0.02; 0.03
Rey *et al*[55], 2014	Spain	1500	> 18	Rome III	Regular sport; Long walks; Short walks; No regular walk	14; 16; 24; 30	1.00; 0.97 (0.66, 1.43); 1.52 (1.06, 2.19); 2.04 (1.23, 3.39)	< 0.01
Wald *et al*[61], 2008	United States, United Kingdom, France, Germany, Italy, Brazil and South Korea	14000	> 15	Self-report (12 mo)	Active; Reduced activity	NR	1.00; 1.23 (1.07, 1.40)	< 0.05
Moezi *et al*[52], 2018	Iran	9264	40-75	Rome IV	Low; Medium; High	10.9[1]; 7.8[1]; 5.6[1]	1.00; 0.74 (0.62, 0.89); 0.56 (0.46, 0.68)	< 0.001

[1]Calculated from data published. NR: Not reported.

Table 8 Smoking and constipation

Ref.	Location	Sample size	Age range (yr)	Definition of constipation	Smoking status	Prevalence (%)	Odds ratio (95%CI)	*P* value
Choung *et al*[65], 2012	United States	2853	> 20	Rome II	Current smoker	26.3	NR	NS
Choung *et al*[83], 2007	United States	7805	20-95	BDQ	Non-smoker; Smoker	16; 20	1.00; 1.40 (0.7, 2.7)	NS
Talley *et al*[49], 1993	United States	690	30-64	Rome I	No cigarettes; > 15/d	20.9; 12.3	4.7 (1.6, 13.7)	< 0.05
Chang *et al*[46], 2007	United States	523	30-64	Rome III	Never; Current; Past; Ever	18.9; 17.3; 17.0; 17.1	1.0; 0.90 (0.47, 1.73); 0.88 (0.53, 1.45); 0.89 (0.57, 1.39)	NS
Haug *et al*[71], 2002	Norway	62651	> 20	Self-report (12 mo)	Non-smoker; Smoker	NR; NR	1.00; 0.83	NR
Papatheodoridis *et al*[51], 2010	Greece	1000	15-64	Rome III or self-report (12 mo)	Active; Inactive	16; 16	NR	0.98
Lu *et al*[56], 2006	Taiwan	2018	> 20	Rome II	Non-smoker; Smoker	8.8[1]; 6.5[1]	NR	NS

[1]Calculated from data published.
NR: Not reported; NS: Not significant; BDQ: Bowel disease questionnaire (similar to Rome criteria).

have found no clear association between body mass index (BMI) and chronic or self-reported constipation[46,50-52,55,65,85].

Other medical conditions: In a review of comorbidities, diabetes was found to be frequently associated with chronic constipation (4.7% to 11.8% of chronic constipation patients) in a comorbidity review[42]. Some, but not all, epidemiological studies have also reported this association[56,69,86].

For chronic constipation, constipation with cardiovascular disease had an odds ratio of 1.5 in one study[69]. In the same study, the odds ratio for constipation in angina was 1.4 and in another study it was 1.86[54]. Stroke was associated with chronic constipation in Brazilian study[66]. Musculoskeletal complaints were found to be associated with chronic constipation[54], including back or joint pain[52]. Urinary tract disorders have also been reported to be associated with constipation[43].

Table 9 Fibre and constipation

Ref.	Location	Sample size	Age range (yr)	Definition of constipation	Dietary intake of fibre	Prevalence (%)	Odds ratio (95%CI)	*P* value
Garrigues *et al*[60], 2004	Spain	349	18-65	Self-report (12 mo)	Low fibre; Medium fibre; High fibre	19.2; 10.9; 20.9	1.00; 0.38 (0.15, 0.96); 1.05 (0.35, 3.17)	0.04; 0.93
Rey *et al*[55], 2014	Spain	1500	> 18	Rome III	1st quintile; 2nd quintile; 3rd quintile; 4th quintile; 5th quintile	23; 18; 17; 18; 20	NR	NS

NR: Not reported; NS: Not significant.

Table 10 Fluid and constipation

Ref.	Location	Sample size	Age range (yr)	Definition of constipation	Fluid intake per day	Prevalence (%)	Odds ratio (95%CI)	*P* value
Rey *et al*[55], 2014	Spain	1500	> 18	Rome III	7 glasses or less; 8-9 glasses; 10-11 glasses; 12-14 glasses; 15 glasses or more	21; 20; 19; 18; 16	NR	< 0.01
Chang *et al*[46], 2007	United States	523	30-64	Rome III	No coffee; Coffee	18.7; 17.8	1.00; 0.94 (0.5, 1.77)	NS

NR: Not reported; NS: Not significant.

Surgery

Recent surgery is well-known to be a risk factor for constipation; this may be associated with medications including general anaesthetics and opioid analgesics as well as being sedentary following surgery. However, the long-term effects of different surgical procedures may contribute to chronic constipation. Gynaecological, abdominal and anorectal surgery were significantly associated with an increased risk of chronic constipation in four epidemiological studies[53,66,69,83] but cholecystectomy and appendectomy were not significant in others[56,65] (Table 14).

Medications

Constipation is a common side effect of many drug classes[87,88] but this is not always evident in population-based studies because few have reported concomitant drug use.

The number of medications used may be associated with chronic or any constipation. In a Norwegian study[54], the use of one or more medications was found to be associated with chronic constipation (Table 15). Aspirin and non-steroidal anti-inflammatory drugs (NSAIDs), particularly ibuprofen, were significantly associated with chronic constipation in this and other studies[46,49,54] (Table 16). Other classes of drugs including digoxin, glyceryl trinitrate, atorvastatin, furosemide and levothyroxine have also been found to be significantly associated with chronic constipation[54].

DISCUSSION

This is the first comprehensive review of epidemiological studies of community populations to present a detailed assessment of real-world evidence relating to all possible potential risk factors for defined adult constipation. This review of studies spanning 30 years of research identified many factors considered to be potentially associated with constipation in community-dwelling adults. These studies frequently refer to these factors as risk factors or potential risk factors for constipation. A risk factor is any factor which is proven to cause an increased prevalence of a disease but in cross-sectional studies only associations can be identified[89]. There are two issues to consider in determining the association of any factor with the prevalence of

Table 11 Alcohol and constipation

Ref.	Location	Sample size	Age range (yr)	Definition of constipation	Weekly alcohol consumption	Prevalence (%)	Odds ratio (95%CI)	*P* value
Choung *et al*[83], 2007	United States	7805	20-95	BDQ	No alcohol; Alcohol	16; 17	1; 1.1 (0.7, 1.7)	NS
Talley *et al*[49], 1993	United States	690	30-64	Rome I	No alcohol; > 7 drinks	19.7; 9.4[1]	3.6 (1.2, 10.4)	< 0.05
Chang *et al*[46], 2007	United States	523	30-64	Rome III	0 drinks; 1-2; 3-6; > 7; Any alcohol	19.3; 19.2; 14.1; 14.9; 16.3	1.0; 0.99 (0.55, 1.79); 0.69 (0.34, 1.39); 0.73 (0.35, 1.53); 0.82 (0.52, 1.29)	NS
Fosnes *et al*[54], 2011	Norway	4622	31-76	Rome II	> Once; < Once	10.6[1]; 14.2[1]	0.94 (0.89, 0.99)	0.024
Choung *et al*[65], 2012	United States	2853	> 20	Rome II	1-6 drinks; 7+ drinks	25.3[1]; 23.1[1]	NR	NS
Moezi *et al*[52], 2018	Iran	9264	40-75	Rome IV	No alcohol; Alcohol	7.9[1]; 9.7[1]	NR	NS
Lu *et al*[56], 2006	Taiwan	2018	> 20	Rome II	No alcohol; Alcohol	8.9[1]; 7.4[1]	NR	NS

[1]Calculated from data published.
NR: Not reported; NS: Not significant; BDQ: Bowel disease questionnaire (similar to Rome criteria).

Table 12 Self-rated health and constipation

Ref.	Location	Sample size	Age range (yr)	Definition of constipation	Self-rated health	Prevalence (%)	Odds ratio (95%CI)	*P* value
Ebling *et al*[50], 2014	Croatia	658	20-69	Rome III	Lower	NR	0.628	< 0.001
Enck *et al*[75], 2016	Germany	15002	> 18	Self-report (12 mo)	Very good; Good; Satisfactory; Less good; Bad	9.1[1]; 12.2[1]; 18.4[1]; 22.1[1]; 28.2[1]	NR	< 0.001

[1]Calculated from data published. NR: Not reported.

constipation in population-based studies. Firstly, the studies investigating factors associated with constipation have been cross-sectional which precludes any links to causality[89]. Factors identified as being associated with constipation could be potential risk factors, or they could be caused by constipation or both. For example, factors such as poor self-rated health, haemorrhoids and depression may be either risk factors for constipation or these factors could be resulting from constipation itself. In the case of haemorrhoids, it is hypothesized that the straining of constipation leads to the development of haemorrhoids[43]. Secondly, published cross-sectional studies investigating factors associated with constipation have tended to focus on a small number of factors of interest, ignoring other factors which may be confounding variables. For example, drugs used by participants may cause constipation as a side effect and this may influence the results obtained. If a wide range of factors is not studied, the possibility of confounding bias exists and diminishes the value of the results[90]. In the period of this review, there has been no comprehensive epidemiological study which has investigated a wide range of associated factors in the same population sample. In addition, many early studies have assessed factors only on univariate analysis, not multivariate, and therefore have not taken all confounding variables into account when determining which factors are associated with constipation.

Table 13 Medical conditions and constipation

Ref.	Location	Sample size	Age range (yr)	Definition of constipation	Condition	Prevalence (%)	Odds ratio (95%CI)	*P* value
Schmidt *et al*[66], 2016	Brazil	2162	> 18	Rome III	Fistula; Haemorrhoids; Anal fissures; Nervous disease; Stroke	54.5; 29.3; 35.8; 24.5; 48.3	3.8 (1.5, 9.7); 1.9 (1.3, 2.7); 2.2 (1.3, 3.6); 1.6 (1.1, 2.1); 5.3 (2.3, 12.1)	NR
Cheng *et al*[57], 2003	Hong Kong	3282	18-80	Rome II	Anxiety; Depression	NR	NR	< 0.0001; < 0.0001
Koloski *et al*[84], 2002	Australia	2910	> 18	Rome I	Anxiety; Depression	5.6; 4.2	NR	< 0.05; < 0.05
Bytzer *et al*[86], 1989	Australia	8185	> 18	BDQ	Control; Diabetes mellitus	9.2; 11.4	1.00; 1.54	NR
Choung *et al*[69], 2016	United States	2327	> 25	Rome III	Rectal cancer; Neurological dis; Parkinson's dis; Multiple sclerosis; Metabolic dis; Cardiovascular dis; Angina; Psychiatric disorder	NR	4.7 (1.0, 22.2); 1.5 (1.1, 1.9); 6.5 (2.9, 14.4); 5.5 (1.9, 15.8); 1.4 (1.1, 1.9); 1.5 (1.1, 1.9); 1.4 (1.1, 1.9); 1.3 (1.0, 1.7)	NR
Choung *et al*[65], 2012	United States	2853	> 20	Rome II	Dyspepsia; GORD	46.9; 34.3	NR; NR	< 0.01; < 0.01
Enck *et al*[75], 2016	Germany	15002	> 18	Self-report (12 mo)	Back pain; Circulation problem; Gynecological; Urological; Gastrointestinal	19.0[1]; 25.2[1]; 35.1[1]; 34.3[1]; 31.6[1]	NR	< 0.001 < 0.001; < 0.001 < 0.001; < 0.001
Ebling *et al*[50], 2014	Croatia	658	20-69	Rome III	BMI; Anemia	NR; 40.0	1.051; NR	0.777; < 0.01
Chang *et al*[46], 2007	United States	523	30-64	Rome III	BMI 1st Q; BMI 2nd Q; BMI 3rd Q; BMI 4th Q	19.4; 13.6; 18.0; 20.7	1.0; 0.65 (0.32, 1.32); 0.92 (0.46, 1.82); 1.07 (0.55, 2.10)	NS
Rey *et al*[55], 2014	Spain	1500	> 18	Rome III	Normal; Overweight; Obese	22; 15; 20	NR	NR
Papatheodoridis *et al*[51], 2010	Greece	1000	15-64	Rome III or self-report (12 mo)	Underweight; Normal weight; Overweight; Obese	18; 14; 17; 20	NR	0.21
Pourhoseingholi *et al*[85], 2008	Iran	2547	NR	Self-report (NTP)	BMI < 25; BMI 25-30; BMI > 30	40.4; 38.9; 40.7	NR	NS
Haug *et al*[71], 2002	Norway	60998	> 20	Self-report (12 mo)	Anxiety; Depression	NR; NR	1.86 (1.67, 2.07); 1.46 (1.30, 1.65)	NR
Fosnes *et al*[54], 2011	Norway	4622	31-76	Rome II	BMI; M/S complaints; Angina; MS	NR	0.95 (0.93, 0.97); 1.04 (1.002, 1.09); 1.86 (1.21, 2.85); 2.14 (1.03, 5.66)	< 0.001; 0.042; 0.004; 0.043
Lu *et al*[56], 2006	Taiwan	2018	> 20	Rome II	Diabetes; Hypertension	14.1[1];11.1[1]	NR	NS; NS
Moezi *et al*[52], 2018	Iran	9264	40-75	Rome IV	Insomnia; Anxiety; Depression; Back or joint pain; GORD	13.5[1]; 11.7[1]; 12.4[1]; 9.4[1]; 11.7[1]	1.62 (1.36, 1.93); 1.38 (1.15, 1.65); 1.22 (1.01, 1.48); 1.38 (1.14, 1.67); 1.51 (1.28, 1.78)	< 0.001; < 0.001; < 0.001; < 0.001; < 0.001

[1]Calculated from data published.

NR: Not reported; NS: Not significant; BDQ: Bowel disease questionnaire (similar to Rome criteria); BMI: Body mass index; M/S: Musculoskeletal; MS: multiple sclerosis; GORD: Gastroesophageal reflux disease.

In assessing the results of studies reviewed, it is clear that there is insufficient evidence for an association of most factors with constipation (Table 17). Regarding demographic factors, female gender is strongly associated with an increased prevalence of constipation; there are various possible explanations for this such as the influence of sex hormones[40]. There is no clear evidence that increasing age is associated with increased constipation. Contrary to widespread beliefs, many epidemiological studies show higher prevalence of constipation in younger age groups. Whilst increasing age effects may be explained by anatomical changes or medications[40],

Table 14 Surgery and constipation

Ref.	Location	Sample size	Age range (yr)	Definition of constipation	Surgery	Odds ratio (95%CI)	*P* value
Choung *et al*[83], 2007	United States	7805	20-95	BDQ	Abdominal	1.2 (0.7, 2.0)	NS
Choung *et al*[69], 2016	United States	2327	> 25	Rome III	Anorectal surgery; Hysterectomy	3.3 (1.2, 9.1); 1.5 (1.0, 2.2)	0.02; 0.033
Schmidt *et al*[66], 2016	Brazil	2162	> 18	Rome III	Anorectal surgery	5.3 (2.3, 12.1)	NR
Lu *et al*[56], 2006	Taiwan	2018	> 20	Rome II	Appendectomy; Cholecystectomy; Hysterectomy	NR	NS; NS; NS
Sorouri *et al*[53], 2010	Iran	18180	NR	Rome III	Abdominal surgery	0.66 (0.52, 0.83)	< 0.01

NR: Not reported; NS: Not significant; BDQ: Bowel disease questionnaire (similar to Rome criteria).

Table 15 Number of medications and constipation

Ref.	Location	Sample size	Age	Definition of constipation	Number of drugs taken	Odds ratio (95%CI)	*P* value
Fosnes *et al*[54], 2011	Norway	4622	31-76	Rome II	0; 1; 2-3; 4 or more	1; 1.34 (1.07, 1.69); 1.26 (0.99, 1.61); 1.21 (0.85, 1.71)	0.012; 0.062; 0.288

Table 16 Medications and constipation

Ref.	Location	Sample size	Age range (yr)	Definition of constipation	Medications	Prevalence (%)	Odds ratio (95%CI)	*P* value
Fosnes *et al*[54], 2011	Norway	4622	31-76	Rome II	Digoxin; GTN; Furosemide; Atorvastatin; Tibolone; Levothyroxine; Ibuprofen	NR	NR	0.025; 0.015; 0.001; 0.037; 0.038; < 0.001; 0.001
Talley *et al*[49], 1993	United States	690	30-64	Rome I	Aspirin > 7 tabs/wk	31.1	2.6 (1.2, 5.7)	< 0.05
Chang *et al*[46], 2007	United States	523	30-64	Rome III	Paracetamol; Aspirin; NSAIDs	25.3; 23.0; 26.6	1.50 (0.91, 2.47) 1.67 (1.04, 2.70) 1.80 (1.09, 2.98)	NS; < 0.05; < 0.05

GTN: Glyceryl trinitrate; NSAIDs: Non-steroidal anti-inflammatory drugs; NR: Not reported; NS: Not significant.

there is no obvious explanation for the high prevalence of constipation in younger adults. Geographic location within a country may be associated with constipation and there are indications that ethnicity may also be associated, however there are conflicting data regarding marital status. The data for socioeconomic factors such as income levels, educational levels and work status are conflicting and appear to vary by country. Similarly, the data for lifestyle factors is mixed. Whilst there is evidence that low physical activity levels are associated with constipation, there is only limited evidence for low fluid intakes and no evidence for low fibre intakes. The effects of smoking, alcohol, and coffee on constipation are unclear and could not be confirmed in this review. However, it is clear that some health-related factors are associated with constipation. This includes low self-rated health, some surgical procedures, some medications, and various medical conditions including depression, haemorrhoids, neurological diseases and some gastrointestinal, cardiovascular and musculoskeletal disorders.

Further research is required to comprehensively assess each of these factors. There are many variations and complexities involved in the epidemiological studies conducted to date. Firstly, differences in population samples, study designs, data

Table 17 Summary of evidence from population-based studies for factors potentially associated with constipation

Category	Factor	Association with constipation
Demographic	Age	Conflicting data, probably only > 70 yr
	Female gender	Associated
	Income level	Conflicting data, probably country specific
	Educational level	Conflicting data, probably country specific
	Residential location	Associated
	Work status	Conflicting data
	Marital status	Conflicting data
	Ethnicity	Possible association
Lifestyle	Physical activity	Associated
	Fibre	No evidence for low fibre
	Fluid	Possible association
	Smoking	Conflicting data
	Alcohol	No clear evidence
	Coffee	No association
Health-related	Self-rated health	Associated
	Obesity	Conflicting data
	Depression	Associated
	Anorectal	Associated – haemorrhoids and other conditions
	Gastrointestinal	Associated
	Neurological	Associated – MS, Parkinson's disease
	Endocrine	Associated - diabetes
	Cardiovascular	Associated
	Musculoskeletal	Associated
	Surgery	Associated – gynaecological, anorectal, abdominal
	No. of medications	Possible association
	NSAIDs	Associated
	Aspirin	Associated
	Other drugs	Possible association

NSAIDs: Non-steroidal anti-inflammatory drugs; MS: Multiple sclerosis.

collection methods and analyses may contribute to the different results obtained. Also, results may be affected by differences in the constipation definition – different criteria used to define chronic or any constipation[3]. Similarly, different criteria used to define comorbid conditions will affect results[42]. When considering comorbid conditions, it is possible that medications being used as treatment may be causing, wholly or in part, the constipation. This could certainly be the case in conditions such as depression, musculoskeletal disorders and cardiovascular diseases where constipation is a known side effect of many medications used for treatment[87,88]. Any increased prevalence of constipation with age may be more related to secondary causes such as comorbid conditions and medications[91]. Most constipation management protocols recommend increases in dietary fibre, fluid intake and physical activity[9,92,93]; there is the possibility that any studies showing high levels of these factors being associated with high constipation prevalence may be indicating that these are consequences of constipation management rather than risk factors for constipation.

This comprehensive and contemporary review of studies conducted in community settings extends earlier work that questioned the existence of real-world evidence for potential risk factors of constipation[4,5]. The strengths of this review are the restriction to population-based studies of community-dwelling adults and the restriction to studies where defined constipation (any or chronic), rather than stool characteristics, was assessed. Also this review was restricted to cross-sectional surveys of the community and excluded studies of convenience samples such as patient or employee groups which were considered not to reflect community settings. One limitation is the risk of bias because only articles published in English were reviewed which may have restricted studies of non-white populations. However, earlier reviews reported a lack of available data from developing countries[7,36].

CONCLUSION

Apart from female gender, residential location, physical activity and some health-related factors, it is unclear whether most other potential risk factors are associated with constipation because of insufficient evidence or conflicting data. In view of the complexities involved in previous research, it is essential that further research is conducted in community-dwelling adult populations to better understand the importance of each risk factor in constipation. It is recommended that a broad range of factors be investigated in same population samples using multivariate analysis to uncover which factors are associated with any constipation or chronic constipation in the community.

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