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

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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
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 |
|------|----------|-------------|----------------------------|----------------|----------------|---------------------|---------|
| Hazari 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 |
| Cheung et al.[63], 2006 | United States | 3022 | Self-report (12 mo) | < 50; > 50 | 1.32; 7.87 | NR | NR |
| Wald et al.[61], 2008 | United States | 2000 | Self-report (12 mo) | < 29; 30-44; 45-59; > 60 | 13.4; 19.1; 17.5; 19.9 | 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 |
| Meinders et al.[47], 2017 | Netherlands | 1259 | Rome III | 18-34; 35-46; 47-55; 56-64; > 65 | 36.3; 26.6; 19.0; 19.2; 19.8 | NR | < 0.001 |
| Garrigues et al.[64], 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 | 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; 0.10 |
| Wald et al.[61], 2008 | United Kingdom | 2000 | Self-report (12 mo) | < 29; 30-44; 45-59; > 60 | 5.9; 7.7; 8.1; 9.1 | NR | NR |
| Wald et al.[61], 2008 | France | 2000 | Self-report (12 mo) | < 29; 30-44; 45-59; > 60 | 12.2; 12.4; 9.4; 22.0 | NR | NR |
| Wald et al.[61], 2008 | Germany | 2000 | Self-report (12 mo) | < 29; 30-44; 45-59; > 60 | 1.5; 4.3; 5.5; 8.7 | NR | NR |
| Wald et al.[61], 2008 | Italy | 2000 | Self-report (12 mo) | < 29; 30-44; 45-59; > 60 | 5.8; 6.9; 8.9; 10.6 | NR | NR |
| Wald et al.[59], 2010 | China | 2100 | Self-report (12 mo) | < 29; 30-44; 45-59 | 12.7; 16.0; 18.6 | NR | NR |
| Wald et al.[59], 2010 | Indonesia | 2000 | Self-report (12 mo) | < 29; 30-44; 45-59; > 60; | 11.6; 13.5; 15.3; 9.6 | NR | NR |
| Wald et al.[59], 2010 | South Korea | 2000 | Self-report (12 mo) | < 29; 30-44; 45-59; > 60; | 18.1; 15.6; 16.9; 14.1 | 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 |
| Sorousi et al.[53], Iran | 18180 | Rome III | < 40; 40-66; > 69 | 1.4; 4.7; 4.9 | 1.01 (1, 1.01) | < 0.05 |
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[32,66] 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,
| 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<sup>3</sup> | 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<sup>3</sup> | 1.6 (1.1, 2.3) | NR |
| Talley *et al.*[49], 1993 | United States | 690 | 30-64 | Self-report Rome I | 2.7; 18.3 | 7.3; 20.1 | 2.70<sup>3</sup>; 1.01<sup>3</sup> | NR | NR |
| Drossman *et al.*[44], 1993 | United States | 5430 | > 15 | Rome I | 2.4 | 4.8 | 2.00<sup>3</sup> | 1.99 (1.5, 2.7) | NR |
| Stewart *et al.*[68], 1999 | United States | 10018 | > 18 | Rome II | 12.0 | 16.0 | 1.33<sup>3</sup> | NR | NR |
| Pare *et al.*[65], 2001 | Canada | 1149 | > 18 | Self-report (3 mo) | 18.4 | 35.4 | 1.92<sup>3</sup> | NR | NR |
| Pare *et al.*[65], 2001 | Canada | 1149 | > 18 | Rome I | 12.0 | 21.0 | 1.79<sup>3</sup> | NR | NR |
| Pare *et al.*[65], 2001 | Canada | 1149 | > 18 | Rome II | 8.3 | 21.1 | 2.54<sup>3</sup> | NR | NR |
| Choung *et al.*[63], 2006 | United States | 2718 | 20-95 | Self-report (12 mo) | 2.76<sup>3</sup> | 6.44<sup>3</sup> | 2.33<sup>3</sup> | 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], 2000 | United States | 2000 | > 15 | Self-report (12 mo) | 13.6 | 21.4 | 1.57 | NR | NR |
| Choung *et al.*[65], 2012 | United States | 2833 | > 20 | Rome II | 20.1<sup>1</sup> | 27.7<sup>1</sup> | 1.38<sup>1</sup> | 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<sup>3</sup> | NR | NR |
| Meindls *et al.*[47], 2017 | Netherlands | 1259 | > 18 | Rome III | 18.8 | 29.3 | 1.56<sup>3</sup> | 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<sup>3</sup> | NR | < 0.01 |
| Garrigues *et al.*[60], 2004 | Spain | 349 | 18-65 | Self-report (12 mo) | 18.0 | 40.1 | 2.23<sup>3</sup> | 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<sup>3</sup> | 4.58 (1.98, 10.60) | 0.0004 |
| Walter *et al.*[22], 2002 | Sweden | 1610 | 31-76 | Self-report (NTP) | 7.3 | 19.8 | 2.39<sup>3</sup> | NR | < 0.0001 |
| Haug *et al.*[71], 2002 | Norway | 62651 | > 20 | Self-report (12 mo) | 1.5 | 5.7 | 3.8<sup>3</sup> | NR | < 0.05 |
| Fosnes *et al.*[54], 2011 | Norway | 4622 | 31-76 | Rome II | 6.7<sup>2</sup> | 19.3<sup>2</sup> | 2.88<sup>3</sup> | 3.24 (2.61, 4.02) | < 0.001 |
| Gaburri *et al.*[72], 1989 | Italy | 519 | NR | Self-report (3 yr) | 1.2<sup>1</sup> | 8.1<sup>1</sup> | 6.75<sup>3</sup> | NR | NR |
| Heaton *et al.*[73], 1993 | United Kingdom | 1892 | 26-69 | Self-report (NTP) | 14.7 | 31.1 | 2.12<sup>3</sup> | 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 Peela *et al.*[74], 2014 | Spain | 7341 | > 16 | Self-report (NTP) | 1.9 | 5.9 | 3.1<sup>3</sup> | NR | < 0.001 |
| Enck *et al.*[75], 2016 | Germany | 15002 | > 18 | Self-report (12 mo) | NR | NR | 2.3 | NR | NR |
| Ehling *et al.*[50], 2014 | Croatia | 658 | 20-70 | Rome III | 24.3 | 20.3 | 0.84<sup>3</sup> | NR | 0.2260.126 |
| Papatheodoridis *et al.*[51], 2010 | Greece | 1000 | 15-64 | Rome III or self-report (12 mo) | 11 | 21 | 1.91<sup>3</sup> | 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 |
| Citation          | Country | Age (yr) | Constipation Type | Method | Prevalence (% | 95% CI | Sex Ratio | Time Period | Country Prevalence | Study Notes |
|-------------------|---------|----------|-------------------|--------|---------------|--------|-----------|-------------|-------------------|-------------|
| Wald et al[59], 2010 | Colombia | > 15     | Self-report       |        | 14.7          | 28.3   | 1.93      | NR          | NR                |             |
| Schmidt et al[66], 2016 | Brazil   | > 18     | Rome III          |        | 5.3           | 21.9   | 4.13      | 4.3 (3.1, 6.1) | NR                |             |
| Ho et al[76], 1998  | Singapore | 21-95    | Rome II           |        | 2.8           | 5.6    | 2.0       | NR          | NR                |             |
| Chen et al[77], 2000 | Singapore | > 16     | Rome II           |        | 3.6           | 11.3   | 3.14      | < 0.05      | NR                |             |
| Cheng et al[57], 2003 | Hong Kong | 18-80   | Rome II           |        | 13.9          | 14.5   | 1.04      | NR          | NR                |             |
| Lu et al[56], 2006  | Taiwan   | > 20     | Rome II           |        | 7.0<sup>1</sup> | 10.6<sup>1</sup> | 1.51<sup>1</sup> | < 0.001   | NR                |             |
| Chang et al[78], 2012 | Taiwan   | > 19     | Rome III          |        | 2.8           | 6.2    | 2.21<sup>1</sup> | 0.001      | NR                |             |
| Jun et al[58], 2006  | South Korea | > 15  | Self-report (3 mo) |        | 10.4          | 22.8   | 2.19<sup>1</sup> | < 0.001   | NR                |             |
| Jeong et al[79], 2008 | South Korea | 18-69 | Rome II           |        | 0.5           | 5.0    | 10.0<sup>1</sup> | < 0.05      | NR                |             |
| Wald et al[61], 2008 | South Korea | > 15   | Self-report (12 mo) |        | 10.7          | 22.7   | 2.12<sup>1</sup> | NR          | NR                |             |
| Tamura et al[23], 2016 | Japan    | 20-79    | Self-report (NTP) |        | 19.1          | 37.5   | 1.96<sup>1</sup> | < 0.001   | NR                |             |
| Wald et al[59], 2010 | Indonesia | > 15    | Self-report (12 mo) |        | 10.7          | 15.1   | 1.41<sup>1</sup> | NR          | NR                |             |
| Wald et al[59], 2010 | China     | 15-60    | Self-report (12 mo) |        | 10.8          | 19.7   | 1.82<sup>1</sup> | NR          | NR                |             |
| Sorouri et al[53], 2010 | Iran     | 18-80   | Self-report       |        | 1.2           | 3.7    | 3.08<sup>1</sup> | 1.83 (1.44, 2.32) | < 0.01         |             |
| Moezi et al[52], 2018 | Iran     | 40-75    | Rome IV           |        | 6.7           | 9.3    | 1.44<sup>1</sup> | < 0.001   | NR                |             |
| Talley et al[80], 1998 | Australia | > 18    | BSQ               |        | 6.3           | 21.1   | 3.35<sup>1</sup> | NR          | NR                |             |
| Howell et al[48], 2006 | Australia | 25-64   | Rome II           |        | 25.1          | 36.0   | 1.43<sup>1</sup> | NR          | NR                |             |
| Koloski et al[81], 2015 | Australia | > 18   | Rome III          |        | 3.25<sup>1</sup> | 8.95<sup>1</sup> | 2.73<sup>1</sup> | NR          | NR                |             |

<sup>1</sup>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<sup>45,46,51,55,57,65,68</sup>. Most North American studies<sup>38,45,61,67</sup> 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<sup>61,75</sup>, there was an inverse relationship between any constipation and educational level but the opposite was found in Brazil, China and Indonesia<sup>59,61</sup>. No trends were found in Spain, Argentina and Colombia<sup>59,60</sup>.

**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<sup>41</sup>. However, in Croatia there was a significantly higher prevalence of chronic constipation in urban populations<sup>50</sup>. Regional differences have also been reported for any constipation in Canada and Greece<sup>45,51</sup> and in Spain for chronic constipation<sup>55</sup>.

**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<sup>75</sup> but in North America chronic constipation seems to be more prevalent in those working<sup>45,49</sup>. 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<sup>44</sup>. Ethnicity differences have also been reported in China<sup>41</sup>.
| 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; $20-29900; $40-59900; $60-79900; > $80000 | 33.6; 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; $20-29900; $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; $20-29900; $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; 16.3; 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; 2500-3000; 3000-4000; > 4000 | 19.0; 18.8; 14.6; 13.6; 13.3; 11.3; 11.5 | 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; 1.5-1.5; 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 | 16.1; 1.7; 1.67; 1.75; 1 | NR | 0.044 |
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\cite{52,55} and any constipation\cite{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\cite{52,83} have suggested that smoking may be a possible risk factor in chronic constipation. However, other United States studies\cite{46,65} and studies in Greece and Taiwan\cite{51,56} found no significant differences in the prevalence of chronic constipation in smokers and non-smokers. Furthermore, one United States study\cite{49} and one study in Norway\cite{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\cite{60} and in another Spanish study there was no significant association with chronic constipation\cite{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\cite{55}. One United States study showed no association of coffee with chronic constipation\cite{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\cite{49} and also in a Norwegian study\cite{54}. A similar trend was observed in Taiwan\cite{56} and other United States studies, but the opposite trend was found in Iran, but no relationships reached significance\cite{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\cite{50,75} (Table 12).

1Calculated from data published.

Note: Income is stated in various currencies. NR: Not reported; NS: Not significant.
### 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. [66], 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. [63], 2007 | United States | 3022 | 20-95 | BDQ | < HS; HS/College; > College | NR | 1.3 (0.5, 3.1); 1.0; 0.8 (0.3, 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, 2.40); 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 |
| Elbing et al. [50], 2014 | Croatia | 658 | 20-69 | Rome II | < 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. [59], 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], 2010 | China | 2100 | 15-60 | Self-report (12 mo) | < Secondary; Secondary; | 10.2; 16.5; 14.4 | NR | NR |
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 |
| Cheong et al [53], 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; 13.3; 18.3 | 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
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].

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**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; 7.8; 5.6 | 1.00; 0.74 (0.62, 0.89); 0.56 (0.46, 0.68) | < 0.001 |

1Calculated 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[63], 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[71], 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; 6.5 | NR | NS |

1Calculated from data published.

NR: Not reported; NS: Not significant; BDQ: Bowel disease questionnaire (similar to Rome criteria).
### 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; 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
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 (yr) | Age range (yr) | Definition of constipation | Condition | Prevalence (%) | Odds ratio (95% CI) | P value  |
|---------------------------------------------------------------------|----------------|------------------|----------------|-----------------------------|-----------|----------------|---------------------|----------|
| Schmidt et al[46], 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 | < 0.0003; < 0.001 |
| 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); 6.3 (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 |
| Ebbing 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 1 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 (0.53, 2.10) | NS      |
| Rey et al[55], 2014                                                 | Spain          | 1500             | > 18           | Rome III                    | Normal; Overweight; Obese | 22; 15; 20 | NR | NR |
| Papanicolaou 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      |
| Fonnies 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; 11.1 | NR | NS; NS |
| Moezi et al[82], 2018                                               | Iran           | 9264             | 40-75          | Rome IV                     | Insomnia; Anxiety; Depression; Back or joint pain; GORD | 13.5; 11.7; 12.4; 9.4; 11.7 | 1.62 (1.36, 1.93); 1.38 (1.15, 1.63); 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 |

1Calculated 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].
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

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**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 range (yr) | 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.
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.
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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