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TOPIC HIGHLIGHT

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# Epidemiological studies of migration and environmental risk factors in the inflammatory bowel diseases

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## Abstract

Inflammatory bowel diseases (IBD) are idiopathic chronic diseases of the gastrointestinal tract well known to be associated with both genetic and environmental risk factors. Permissive genotypes may manifest into clinical phenotypes under certain environmental influences and these may be best studied from migratory studies. Exploring differences between first and second generation migrants may further highlight the contribution of environmental factors towards the development of IBD. There are few opportunities that have been offered so far. We aim to review the available migration studies on IBD, evaluate the known environmental factors associated with IBD, and explore modern migration patterns to identify new opportunities and candidate migrant groups in IBD migration research.



**Key words:** Inflammatory bowel disease; Crohn's disease; Ulcerative colitis; Epidemiology; Risk factor; Environment; Hygiene hypothesis

**Core tip:** Inflammatory bowel diseases (IBD) are well known to involve genetic and environmental risk factors. Cohorts from low IBD prevalence regions migrating to areas of high IBD prevalence are candidates to assess further environmental factors - both protective and promotional. There are few opportunities to identify migratory populations to highlight these effects of environmental risk factors in the development of IBD and to compare first- and second-generation migrants. This review highlights known migratory cohorts and identifies an emerging cohort in Middle Eastern migrants to Australia.

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## INTRODUCTION

Inflammatory bowel diseases (IBD) are idiopathic chronic diseases of the gastrointestinal tract well known to be associated with both genetic and environmental risk factors. With increasingly new and powerful genetic techniques, it is worthwhile to re-evaluate the contribution of the environment to the development of both Crohn's disease (CD) and ulcerative colitis (UC). To do this, epidemiological research is the key, and such studies have already identified the increasing global incidence and prevalence of IBD in developing countries as these countries become more developed and "Westernised", highlighting the significance of environmental factors on influencing IBD development globally[1]. However, despite the no-

table amount of studies already conducted on this issue, many of the suggested environmental risk factors for CD and UC still remain contentious in regards to their exact relationship with the diseases[2].

Currently, only smoking has been an established risk factor for CD[3] but paradoxically is protective for UC as found by several studies[4-6]. There seems to be a dose-response relationship between smoking and IBD[7] and childhood exposure to tobacco smoke is associated with a higher risk of developing CD[8]. A meta-analysis found that oral contraceptive pill (OCP) increased the risk of both CD and UC, with a dose-response relationship for CD, and OCP discontinuation reduced IBD risk[9]. Appendectomies are found to have an inverse relationship with UC[10]. For CD, some suggest insignificant association with appendectomies[11,12], while others demonstrate increased risk[12-15]. A meta-analysis found breastfeeding to be protective for both CD and UC[16]. However, this result is not reproducible by several studies[17,18]. Generally, antibiotics are found to be a risk factor for CD[18-20], and a case-control study has found a positive association between CD and UC[21]. Regarding diet, the literature is inconsistent and no clear dietary risk factors for CD and UC can be determined[2]. Furthermore, there are also investigations into "proxy measures" of the hygiene hypothesis, including family size and rural dwelling. The hygiene hypothesis has notable popularity as it fits the observation that incidence and prevalence of autoimmune diseases including IBD increase in nations with improvements in hygiene as a result of modernisation[22]. Improved hygiene may alter intestinal commensal bacteria colonisation, reduce exposure to infectious diseases and vaccinations, which are all speculated to play a role in IBD pathogenesis[23]. However, many studies investigating factors related to hygiene have conflicting results[24]. Overall, the epidemiological studies on IBD environmental risk factors have produced important but inconsistent findings, and methodological alterations in future studies are worthwhile to be considered.

We propose a different method to approach epidemiological research on IBD environmental risk factors: using migrant groups as the study population of epidemiological studies. Groups migrating from areas of low IBD incidence to areas of high IBD incidence will provide insight into the effects of environmental triggers on disease development better than populations without such a transition in environment due to the shortened interval between risk factor exposure and IBD onset. Furthermore, studying the offspring of migrants will provide new cohort data on generational changes and their relationship with IBD development and highlight the contribution of these environmental factors at different ages. We aim to review the available migration studies on IBD and explore modern migration patterns to identify new opportunities in IBD migration research. In particular, we propose that a suitable migrant group for environmental risk factor studies is the migrant population from the Middle East to a developed country such as Australia.

## SEARCHING

A comprehensive search on the Ovid MEDLINE database (1946 to present) was performed using the following keywords: "inflammatory bowel disease", "CD", "UC", "epidemiology", "incidence", "prevalence", "clinical characteristics", "extraintestinal manifestations", "risk factors" and "migrant". The search was limited to the English language. A manual search of reference lists of all original articles retrieved was also conducted. For migrant studies, 3 were selected after excluding studies which did not investigate at least two generations within migrant groups. To study potential new migration groups that might provide new IBD research opportunities, we searched for epidemiological studies relating to populations of Middle Eastern heritage and their immigration to Australia. The search terms "Middle East", "Arabic" and "Australia" were used and there were a total of 23 IBD articles pertaining to the Middle East and 2 pertaining to Australia. Figure 1 discloses the literature search, included and excluded articles.

## RESEARCH

### *Advantages of migrant studies*

Studies of migrant populations identify disease characteristics of a group in their original location, and trace the group through several generations in the new host country to provide deeper insights into associations between environmental factors and disease expression. Migrant populations have been identified as the most promising model for investigating the changing epidemiology of IBD previously[25]. A criticism of prior risk factor studies is the long time interval between presumed exposure to the environmental trigger and disease development[26], creating uncertainty for etiology. Migrant studies are able to overcome this since migrant cohorts transitioning from developing to developed countries offer a shorter time period between risk factor exposure and disease onset, and many risk factors are postulated to be associated with the lifestyle of developed, Westernised countries. Another advantage is that as immigrants adopt new lifestyles, investigating disease characteristics in successive generations will demonstrate temporal relationships between environmental triggers and development of disease, provided that intermarriage with natives is uncommon[27]. Migrant studies also have the added advantage of overcoming data incompatibility that often occurs when comparing epidemiological data of an ethnic group from a developing country to a similar ethnic group in developed nations due to inequality of diagnostic facilities and healthcare access.

### *Existing migrant studies*

In Leicestershire, United Kingdom, a retrospective cohort study compared the incidence of UC in first and second generation South Asian immigrants to Europeans using both hospital and general practice sources. Stan-

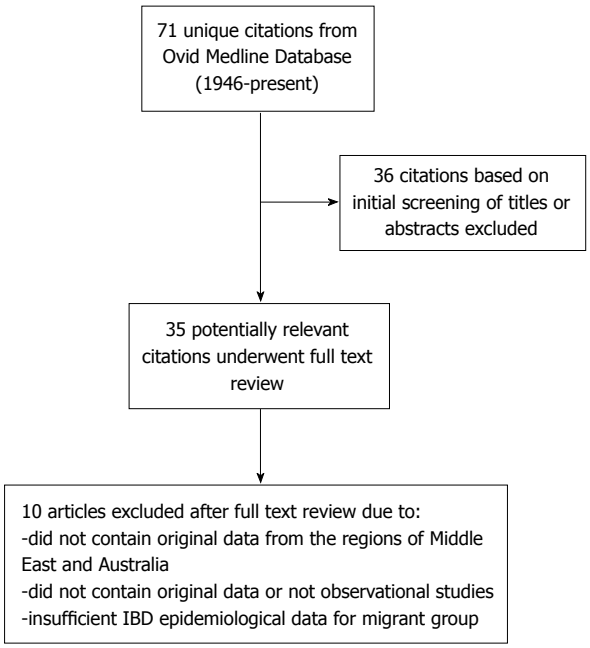


**Figure 1 Included and excluded articles.** IBD: Inflammatory bowel diseases.

dardised UC incidences for Europeans and South Asian migrants were 5.3 per $10^5$ and 10 per $10^5$ respectively. Additionally, disease distribution was similar between the two groups, while bimodal age distribution of UC is evident in the European population but not shared by the South Asian migrants. Although unable to accurately determine UC incidence in the two generations separately, the study estimated that first and second generation South Asians are likely at equal risk in developing UC using age-standardised incidences[28,29]. However, a later prospective multicentre study using hospital-based data also conducted in Leicestershire found higher UC incidences for both the Europeans and South Asian first and second generation immigrants (7.0 per $10^5$ and 17.2 per $10^5$ respectively). Importantly, second generation South Asians were found to suffer higher rates of extensive colitis compared to the first, and were similar to the Europeans[30]. The findings from these two studies challenge earlier Asian epidemiological studies[28,31-42] which reported lower UC incidences, and that environmental impacts cause more severe disease phenotype in later generations. This strongly supports the influential role of environmental risk factors on IBD, which is best investigated by migrant studies comparing successive generations.

Another notable epidemiological study focusing on migrant populations was conducted in Sweden and used a well-defined open cohort study of first and second generation immigrants from 19 countries. The overall IBD risk compared to native-born Swedes was found to be decreased for all first generation immigrants (standard incidence ratios: CD 0.75 per $10^5$, UC 0.81 per $10^5$). However, when separated into individual countries, several migrant groups originating from developing countries showed increased risk (Figure 2). The highest standardised incidence ratio in second generation immigrants for developing CD were those with one parent or two parents born in Iraq (1.85 and 1.99 respectively), and for UC were immigrants with one (1.55) or both parents (1.68) born in Iran[43]. These results not only suggest that environmental risk factors have varying effect on risk of IBD depending on ethnicity, but also confirm that migrants moving from developing to developed countries may be most susceptible in demonstrating the effects of IBD development due to environmental triggers. Furthermore, the study identified that one of the region which contained the greatest rise of IBD incidence in migrants as the Middle East (Lebanon, Iraq and Iran). Despite the lack of confirmed case ascertainment, this nationwide study is the largest study to date which has investigated generational IBD epidemiological patterns for a large range of migrants from developed and developing countries (Figure 2).

Currently, many studies which compare different ethnic groups within developed and developing countries exist[38,44-48]. These studies are able to characterise ethnic differences in IBD, but for purposes of identifying novel risk factors in IBD expression for particular ethnic groups, migrant studies tracing generational changes are superior since genetic variables are controlled. The studies from Leicestershire and Sweden highlight that generational investigations show highly significant IBD epidemiological differences that are most likely due to environmental causes. Unfortunately, the studies have only investigated incidence and prevalence rates. Future studies should additionally investigate risk factor profiles in successive generations. Furthermore, exploring generational changes are important for understanding the role of family history in IBD expression. A study in Leicestershire found the risk of developing UC was 15-fold for first degree relatives of European patients and 3.5-fold for South Asians. However, prevalence in siblings was comparable between the two ethnicities[48]. Examining generational alterations will shed greater light on the role of inheritance versus environmental contribution towards the development of IBD.

When considering the results of migrant studies, one must be aware of their limitations. Health seeking behaviour and health literacy may be lower in migrant groups, hence reducing IBD detection. If this is the case then any increase in incidence and prevalence reported in migrants in developed countries may be even higher than recorded. Generational environmental changes may also mask the absolute risk of developing CD or UC in immigrants[43]. For example Swedish Iranian immigrants have higher smoking rates than Iranians in Iran[49], which may reduce UC incidence for the immigrants as smoking is protective. These examples would reduce the incidence of IBD in migrants. Therefore results that demonstrate an increase in IBD incidence are likely to be of importance. Finally, it is also important to remember that when interpreting risk factor studies, ethnic factors such as diet may be difficult to differentiate from true environmental influences in epidemiological studies[26]. This may affect

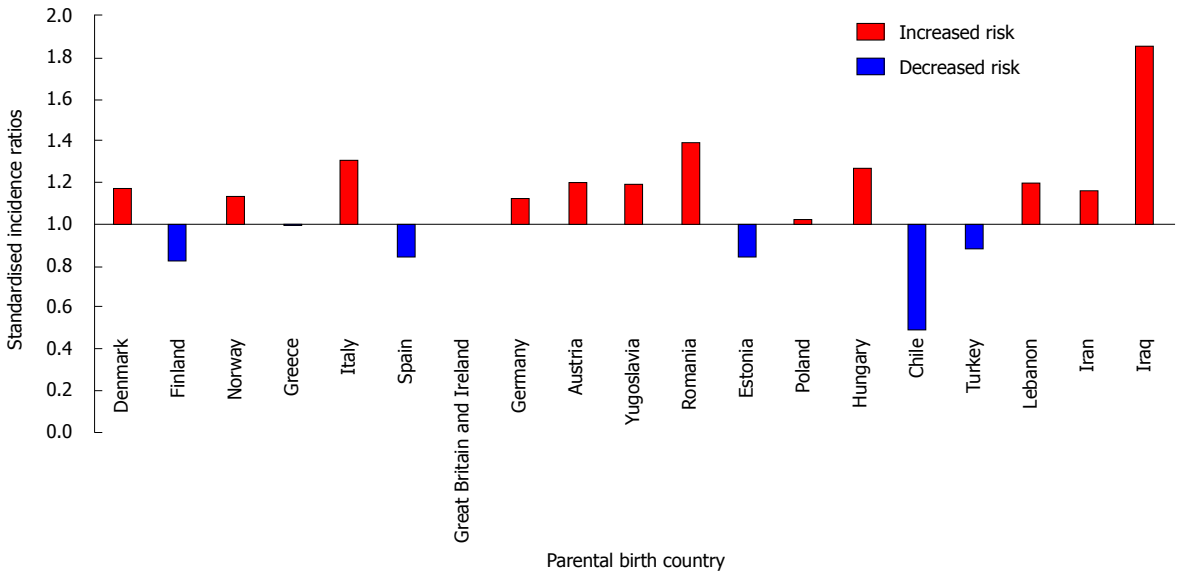


**Figure 2 Summary of standardized incidence ratio for Crohn's disease and ulcerative colitis in second-generation immigrants (adapted from ref. [43]).**

migrant studies which focus on specific ethnic groups. One way to minimise these confounders is to use controls of the same ethnicity and socio-cultural background.

In the light of the findings of previous migrant studies and modern migration patterns, we aim to identify appropriate migrant groups for future epidemiological research on the risk factors of IBD. Ideally, candidate groups should have good quality epidemiological data on IBD in the country of origin and in the host country, particularly in confirming low IBD incidence rates in the country of origin and high IBD incidence rates in the host country. We propose that migrants from the Middle East migrating to developed countries, such as Australia, are suitable candidates for such studies.

## EPIDEMIOLOGY OF IBD IN THE MIDDLE EAST

There is a relatively significant amount of epidemiological research in certain Middle Eastern countries, considering the developing nature of this region. Overall there are 20 incidence[31-34,37,38,47,50-61] and 19 prevalence[31,32,35,36,50,51,53,55,56,58,60,62-65] studies on CD and UC in the Middle East from the countries of Lebanon, Israel, Kuwait, Turkey and Oman. Tables 1 and 2 demonstrate the incidence and prevalence findings of these studies stratified by CD and UC, including references for each specific study. Eleven studies[52-58,64-67] had case ascertainment of UC and CD using the internationally accepted Lennard-Jones criteria, and two were prospective cohort studies[56,59].

### *Incidence and prevalence*

In the Middle East, annual incidence rates for CD range from 1.1 per $10^5$ in Beer Sheva[36] to 5.0 per $10^5$ in the Kibbutz settlements in Israel[55], while ranges were from 1.35 per $10^5$ in Oman[59] to 6.3 per $10^5$ in Jerusalem in Israel[37] for UC. The prevalence rates for CD range from 3.2 per $10^5$ in the Bedouin Arabic population in Southern Israel[62], and 67.9 per $10^5$ in Kibbutz settlements in Israel[64], while ranges were from 4.9 per $10^5$ in Turkey[58] to 168.3 per $10^5$ in the Kibbutz settlements in Israel for UC[66]. Such data indicate that IBD incidence and prevalence are up to 20-fold lower than other locations in the world. In Europe, North America and Australia the highest UC incidence rates of 24.3 per $10^5$, 19.2 per $10^5$ and 17.4 per $10^5$ have been recorded respectively[68]. UC in the Middle East appears to be of much rarer occurrence. This similarly applies for CD when comparing the Middle East to the world's highest incidence rates.

Despite the relatively rarity of disease in the Middle East homelands, some studies are able to provide temporal trends and demonstrate increasing incidence for both UC and CD. This contrasts with the stabilisation of incidence rates in many established high incidence areas in the world such as Scandinavia[69]. This supports the hypothesis that there are risk factors specific to the western lifestyle that increase IBD incidence. The observation that IBD is more common in European-American born Jews compared to Asian-African born Jews in central Israel[31] is consistent with this. On the other hand, such an increase may be artificial, reflecting increasing physician awareness of IBD and access to diagnostic tools. Additionally, reliability of results is reduced by lack of national population-based registries, compromising incidence and prevalence calculations.

### *Demographic features*

There are 6 studies each[31,32,47,50,52,58] which stratify incidence rates by sex and/or age. The female to male ratio for CD ranged from 0.74 per $10^5$ in Tel Aviv Yafo in Israel[31] to 1.43 per $10^5$ in Southern Israel[47], and for UC from 0.59 per $10^5$ in Trakya Turkey[58] to 0.96 per $10^5$ in Tel Aviv Yafo in Israel[32]. Globally, there is a slight female dominance in CD[7,69], but overall sex differences for UC

**Table 1 Summary of incidence rates for Crohn's disease and ulcerative colitis in the Middle East stratified by geographical region**

| Country | Region | Crohn's disease incidence rate ($/10^5$) | Ulcerative colitis incidence rate ($/10^5$) | Method | Study period | Ref. |
|---|---|---|---|---|---|---|
| Israel | Upper Galilee | | 2.33 | Survey based study which included all cases in region | 1967-1986 | Niv *et al*[51], 1990 |
| | Tel Aviv Yafo | 1.55 | | Prospective multicentre study including all hospitals and gastroenterology departments in region | 1970-1980 | Fireman *et al*[31], 1989 |
| | Tel Aviv Yafo | | 3.86 | Population-based study | 1970-1980 | Grossman *et al*[32], 1989 |
| | Tel Aviv Yafo | | 3.66 | Survey based multicenter study with well defined catchment area | 1961-1970 | Gilat *et al*[50], 1974 |
| | Tel Aviv Yafo | 1.28 | | Survey based | 1970-1976 | Rozen *et al*[33], 1979 |
| | Southern Israel | 4.2 | | Hospital and out-patient based, with complete case ascertainment | 1968-1992 | Odes *et al*[47], 1994 |
| | Southern Israel | | 2.98 | Retrospective study, hospital and community clinic based | 1961-1985 | Odes *et al*[34], 1987 |
| | Kinneret Subdistrict | | 3.5 | Population based study | 1965-1994 | Shapira *et al*[52], 1998 |
| | Kinneret Subdistrict | 1.96 | | Hospital serving a well-defined catchment area covering all IBD cases in district | 1960-1990 | Shapira *et al*[53], 1994 |
| | Beer Sheva | | 2.87 | Retrospective study, hospital based | 1961-1985 | Odes *et al*[34], 1987 |
| | Beer Sheva | 1.1 | | Population-based study | 1961-1980 | Krawiec *et al*[36], 1984 |
| | Beer Sheva | 2.1 | 5.4 | Retrospective and prospective cohort study, hospital and community clinic based | 1979-1987 | Odes *et al*[38], 1989 |
| | Jerusalem | | 6.3 | Survey based | 1973-1978 | Jacobsohn *et al*[37], 1986 |
| | Kibbutz settlements | 5.0 | | Community-based survey of physicians | 1987-1997 | Niv *et al*[54], 1999 |
| Lebanon | Kibbutz settlements | | 5.04 | Community-based survey of physicians | 1987-1997 | Niv *et al*[55], 2000 |
| | National | 1.4 | 4.1 | Population based study using a health-maintenance organisation based with large catchment area | 2000-2004 | Abdul-Baki *et al*[56], 2007 |
| Turkey | National | 2.2 | 4.4 | Questionnaire-based multicentre study | 2000-2003 | Tozun *et al*[57], 2009 |
| Oman | Trakya | | 0.77 | Cross-sectional study, hospital based | 1998-2001 | Tezel *et al*[58], 2003 |
| | National | | 1.35 | Prospective cohort study, tertiary referral centre based with large catchment area | 1987-1994 | Radhakrishnan *et al*[59], 1997 |
| Kuwait | National | | 2.8 | Retrospective cohort study, tertiary referral centre based with large catchment area | 1985-1999 | Al-Shamali *et al*[60], 2003 |
| | National | 0.45 | 2.27 | Population-based study | 1977-1982 | Al-Nakib *et al*[61], 1984 |

IBD: Inflammatory bowel diseases

and CD are inconsistent[68], suggesting gender-specific risk factors may not exist. In the Middle East, incidence rates were highest in the second decade of life for CD, and third decade for UC. These peak age groups corresponded to global trend of peak age group in 20 to 29 years old range for both UC and CD[68]. Similarly, the unimodal age distribution found by Middle Eastern studies reflects international results[68,69], as only one third of studies demonstrate bimodal age distribution, all from westernised nations[68]. The significance of a second peak is contentious as it may be due to missed diagnosis when the disease first presented earlier in life. On the other hand, it may indicate populations whose disease is more susceptible to environmental factors rather than genetics, and hence for countries in the Middle East where the one peak age group is relatively older, strong environmental influences may be indicated.

### Clinical features

Thirteen studies[52-56,58-60,62,67,70-74] from the countries of Lebanon, Kuwait, Iran, Oman, Qatar and Israel characterised intestinal and/or extraintestinal involvement in CD and/or UC in Middle Eastern populations. However, classifications of the site of CD and UC intestinal involvement were not uniform in the Middle Eastern studies, nor were methods of case ascertainment and type of colonoscopy used. The most common intestinal feature reported by all the studies for CD is the terminal ileum, followed by colonic only and ileocolonic. Globally, ileocolitis is the most common[72]. For UC, it is most commonly found as proctitis, followed by left-sided colitis and pancolitis in the Middle East. This is largely similar to the

**Table 2 Summary of prevalence rates for Crohn's disease and ulcerative colitis in the Middle East stratified by geographical region**

| Country | Region | Crohn's disease prevalence rate (/$10^5$) | Ulcerative colitis prevalence rate (/$10^5$) | Method | Study period | Ref. |
|---|---|---|---|---|---|---|
| Israel | Upper Galilee | | 44.58 | Survey based study which included all cases in region | 1986 | Niv *et al*[51], 1990 |
| | Tel Aviv Yafo | 13.28 | | Prospective multicentre study including all hospitals and gastroenterology departments in region | 1970-1980 | Fireman *et al*[31], 1989 |
| | Tel Aviv Yafo | | 55.16 | Population-based study | 1980 | Grossman *et al*[32], 1989 |
| | Tel Aviv Yafo | | 37.4 | Survey based multicenter study with well defined catchment area | 1970 | Gilat *et al*[18], 1974 |
| | Tel Aviv Yafo | 12.31 | | Survey-based | 1976 | Rozen *et al*[33], 1979 |
| | Southern Israel | 50.60 | | Hospital and out-patient based, with complete case ascertainment | 1992 | Odes *et al*[47], 1994 |
| | Southern Israel (Arab population) | 3.20 | 9.8 | Prospective cohort study, hospital and community clinic based | 1990 | Odes *et al*[62], 1991 |
| | Kinneret Subdistrict | 20.24 | | Hospital based serving a well-defined catchment area covering all IBD cases in district | 1960-1990 | Shapira *et al*[53], 1994 |
| | Beer Sheva | | 70.6 | Retrospective study, hospital based | 1985 | Odes *et al*[34],1987 |
| | Beer Sheva | 14 | | Population-based study | 1980 | Krawiec *et al*[36], 1984 |
| | Beer Sheva | 30 | 89.0 | Retrospective and prospective cohort study, hospital and community clinic based | 1987 | Odes *et al*[38], 1989 |
| | Kibbutz settlements | 65.1 | | Community-based survey of physicians | 1987-1997 | Niv *et al*[54], 1999 |
| | Kibbutz settlements | | 144.1 | Community-based survey of physicians | 1987-1997 | Niv *et al*[55], 2000 |
| | Kibbutz settlements | | 121.08 | Community-based survey of physicians | 1987 | Niv *et al*[63], 1991 |
| | Kibbutz settlements | | 168.3 | Survey based, complete case ascertainment and large catchment area | 1987-2007 | Birkenfeld *et al*[66], 2009 |
| | Kibbutz settlements | 67.9 | | Survey based, complete case ascertainment and large catchment area | 1987-2007 | Zvidi *et al*[64], 2009 |
| Lebanon | National | 53.1 | 106.2 | Population based study using a health-maintenance organisation based with large catchment area | 2007 | Abdul-Baki *et al*[56], 2007 |
| Turkey | Trakya | | 4.9 | Cross-sectional study, hospital based | 2002 | Tezel *et al*[58], 2003 |
| Kuwait | National | | 41.7 | Retrospective cohort study, tertiary referral centre based with large catchment area | 1985-1999 | Al-Shamali *et al*[60], 2003 |

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extent of UC in other low incidence countries. The most common extraintestinal involvement was rheumatological conditions, a finding reflected worldwide[73].

### Risk factors

Ten studies investigated the risk factor profiles in UC and/or CD populations studied[54-59,64,67,71]. However, only one study - an Iranian study with 258 cases[67] - included controls, highlighting an area that would benefit from more case control studies. The most common risk factor studied was smoking, and generally studies showed smoking as less prevalent in UC subjects, and the opposite for CD. This is consistent with global findings. Results for other risk factors are largely inconsistent between Middle Eastern studies.

### Racial/ethnic differences

Due to significant differences in IBD incidences within different ethnic groups in Israel, such that IBD incidence was highest among American and European born Jews than those born in Israel, Asia and Africa[56], it is worthwhile for future studies to distinguish IBD characteristics according to ethnicity. Interestingly, it is observed that the prevalence gap between different ethnic groups is disappearing in the Kibbutz settlements, Tel Aviv Yafo and the South and North of Israel[66]. Studies also show that the risks of developing UC for European and American born Jews and for Jews born in Israel are becoming very similar[34]. It can be inferred that as these countries become increasingly westernised, IBD becomes more prevalent. Further studies are necessary to identify the environmental components, ideally done through investigating generational changes when there is migration from developing to developed countries.

## EPIDEMIOLOGY OF IBD IN AUSTRALIA

### Incidence and prevalence

Wilson *et al*[74] conducted the first and only prospective population based study to determine Australia's IBD inci-

dence over a period of 1 year using the capture-recapture method with good sample size. The crude annual incidence rate for overall IBD, UC and CD were 29.3 per $10^5$, 17.4 per $10^5$ and 11.2 per $10^5$ respectively. This result in the overall IBD incidence rate of 29.6 per $10^5$ after age-standardised to the World Health Organisation world standard population[74]. When compared to global IBD incidence, the most recent systematic review of regional epidemiology demonstrates that Australia has higher UC rates than Europe (12.7 per $10^5$), Asia and Middle East combined (6.3 per $10^5$), and lower when compared to North America. For CD, compared to Europe (12.7 per $10^5$) and North America (20.2 per $10^5$), Australia's rates are less, while higher than Asia and the Middle East (5.0 per $10^5$)[68]. This study is critical in confirming Australia's high IBD incidence which was not previously established; additionally it supports the assumption that Australia shares similar genetic and environmental risk factors with other westernised nations[74].

An earlier smaller study was conducted in the Hunter Valley region of New South Wales on CD patients between 1967 and 1991. A mean incidence of 1.38 per $10^5$ with a 3-fold increase in incidence rates between the first and second 10 years was found. The prevalence of these patients was 34 per $10^5$. There was a female dominance (1.4:1) and the most common intestinal involvement site was ileocolonic, followed by colonic only, and jejuna[75]. The study's inclusion of only surgically managed CD means there is an underestimation of the total CD incidence in the area.

The short time period of the study conducted by Wilson *et al*[74] is the main limiting factor. Hence in actuality IBD incidence in Australia could be higher. Additionally, further population-based studies conducted over longer periods should stratify results by ethnic subgroups to better represent Australia's IBD epidemiology considering the multiculturalism of this country.

### *Clinical features and environmental risk factors*

Inflammatory bowel disease presentation in Australia is comparable to many Westernised nations. The bimodal age distribution of IBD in Australia, with 20-24 year old age being the peak age group[74], reflects the findings of some Westernised nations[68]. Phenotypically, for CD terminal ileum involvement is most common (49%), followed by colonic only disease (27%) and ileocolonic (24%). For UC, proctosigmoiditis or left sided colitis was most common (48%), followed by isolated proctitis (35%) and pancolitis (17%)[74]. Thus far, there is a lack of epidemiological studies focused on the adult population on environmental risk factors of IBD. A retrospective study on children in the state of Victoria found high prevalence of urban dwelling in cases.

### *Migrant populations*

Multicultural diversity distinguishes Australia. With net overseas migration comprising 53% of Australia's annual population growth[76] it is evident that several generations of migrants populate the country, causing it to be a prime setting to study environmental risk factors of IBD when tracing generational changes. The 2006 census data indicates 193633 people born in the Middle East who were resident in Australia. This accounted for 4.4% of the overseas-born population. Approximately 40% were born in Lebanon, 16.8% were born in Iraq, 15.7% in Turkey, 11.6% in Iran, 4.0% in Israel, 3.6% in Syria and 1.9% in Jordan[77]. Most of the Middle-Eastern - born population reside in Sydney (58.1%). Arrival peaks occurred in 1977 and 1987 coinciding with the Lebanese Civil War. The union of individuals with a common ancestor known as consanguinity is found in the Middle East with a prevalence of 26% in 1988[78]. As IBD has a genetic component it may therefore be more likely to manifest in this migrant group given suitable environmental condition. This migration of Middle Eastern populations to Australia therefore allows for the study of the development of IBD and allows for comparison of first- and second-generation migrants.

## CONCLUSION

Migrant studies exploring generational IBD changes and risk factor profiles contribute towards greater understanding of IBD environmental influences due to the advantages they confer. Modern migration patterns offer unique opportunities for these epidemiological studies. Identifying and studying suitable migrant groups, such as Middle Eastern migrants in Australia, is likely to increase our understanding of the environmental triggers of IBD which thus far remain ambiguous entities.

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