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Prevalence of Inflammatory Bowel Disease  
in the Canton of Vaud (Switzerland):  
A Population-based Cohort Study

**THESE**

Préparée sous la direction du Professeur Pierre Michetti et  
présentée à la Faculté de Biologie et de Médecine de  
l'Université de Lausanne pour  
l'obtention du grade de

*DOCTEUR EN MEDECINE*

par

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# Résumé de Synthèse

## *Prévalence des maladies inflammatoires de l'intestin: Une étude de cohorte sur la population du canton de Vaud (Suisse).*

### 1. Introduction

Etant donné l'évolution constante des données épidémiologiques sur les maladies inflammatoires chroniques de l'intestin (MICI), nous avons recherché à caractériser la prévalence de la maladie de Crohn (MC) et de la colite ulcéreuse (CU) dans une population définie de la Suisse.

### 2. Méthodes

Nous avons identifiés, dans une population délimitée au Canton de Vaud, les patients adultes atteints de maladies inflammatoires de l'intestin en regroupant les données histologiques et médicales disponibles à l'hôpital et au cabinet du gastroentérologue.

Pour nos analyses, nous avons utilisé la méthode de la régression de Poisson afin d'identifier les facteurs démographiques significativement liés avec la prévalence. Ensuite, nos résultats ont été comparés aux valeurs de prévalence des MICI issues d'autres études de population (revue systématique de la littérature) afin de dégager les tendances de leur évolution au cours du temps.

### 3. Résultats

La prévalence des MICI pondérée selon l'âge et le sexe était de 205.7 cas (100.7 MC et 105.0 CU) pour 10<sup>5</sup> habitants. Parmi les 1016 patients identifiés (519 MC et 497 CU), les femmes étaient plus représentées que les hommes dans la MC ( $P < 0.0001$ ), alors que la proportion d'hommes dépassait celle des femmes chez les patients âgés atteints de CU ( $p = 0.008$ ). Par conséquent, le fait d'être un homme était statistiquement associé à la CU (Risque relatif (RR) 1.25,  $p = 0.013$ ), et celui d'être une femme était associé à la MC (RR 1.27 ;  $p = 0.007$ ). L'étude a également montré qu'habiter en zone urbaine était significativement associé avec les deux types de MICI (RR (MC) 1.49;  $p < 0.001$ , (CU) 1.63;  $p < 0.001$ ). Enfin, il a été mis en évidence dans les pays industrialisés, entre 1960 et 2005, une augmentation annuelle des taux de prévalences de 2.4% (95% IC, 2.1%-2.8% ;  $p < 0.001$ ) pour la MC et de 3.6% (95% IC, 3.1%-4.1% ;  $p < 0.001$ ) pour la CU.

### 4. Conclusion

L'extrapolation de nos données au niveau Suisse fournit une estimation de 12 000 cas de MICI pour le pays soit 1 cas pour 500 habitants.

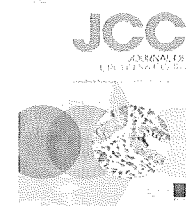
Notre étude contribue également à démontrer une augmentation de la prévalence des MICI en Europe.

#### Mots clés :

Maladie de Crohn, colite ulcéreuse, maladies inflammatoires chroniques de l'intestin, épidémiologie, revue de littérature.



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## Prevalence of Inflammatory Bowel Disease in the Canton of Vaud (Switzerland): A population-based cohort study<sup>☆</sup>

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### KEYWORDS

Crohn's disease;  
Ulcerative colitis;  
Inflammatory bowel diseases;  
Epidemiology;  
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### Abstract

**Background and aims:** Because of the changing epidemiology of Inflammatory Bowel Diseases (IBD), we set out to characterize the population-based prevalence of Crohn's Disease (CD) and Ulcerative Colitis (UC) in a defined population of Switzerland.

**Methods:** Adult IBD patients were identified by a cross-matched review of histological, hospital and gastroenterologist files throughout a geographical defined population (Canton of Vaud). Demographic factors statistically significantly associated with prevalence were evaluated using a stepwise Poisson regression analysis. Results were compared to IBD prevalence rates in other population-based studies and time trends were performed, based on a systematic literature review. **Results:** Age and sex-adjusted prevalence rates were 205.7 IBD (100.7 CD and 105.0 UC) cases per 10<sup>5</sup> inhabitants. Among 1016 IBD patients (519 CD and 497 UC), females outnumbered males in CD ( $p < 0.001$ ), but males were more represented in elderly UC patients ( $p = 0.008$ ). Thus, being a male was statistically associated with UC (Relative Risk (RR) 1.25;  $p = 0.013$ ), whereas being a female was associated with CD (RR 1.27;  $p = 0.007$ ). Living in an urban zone was associated with both CD and UC (RR 1.49;  $p < 0.001$ , 1.63;  $p < 0.001$ , respectively). From 1960 to 2005, increases in UC and CD prevalences of 2.4% (95%CI, 2.1%–2.8%;  $p < 0.001$ ) and 3.6% (95%CI, 3.1%–4.1%;  $p < 0.001$ ) per annum were found in industrialised countries.

<sup>☆</sup> Parts of this work were presented at the meeting of the Swiss Gastroenterology and Hepatology Society (SSGH) in 2005 and at the Journées Francophones de Pathologie digestive in 2006 and 2007.

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**Conclusions:** Extrapolating our data to all of Switzerland yields an estimate of 12,000 IBD cases for the country, or 1 in 500 inhabitants. Our study gives support to an increase in IBD prevalence in Europe.

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## 1. Introduction

Crohn's Disease (CD) and Ulcerative Colitis (UC), the two major subtypes of Inflammatory Bowel Diseases (IBD), are characterized by chronic inflammation of the bowel, immunologically mediated and probably resulting of a loss of tolerance to the endogenous enteric flora, inducing an inappropriate activation of the mucosal immune system.<sup>1,2</sup> Although the cause remains unclear, extrinsic environmental factors play probably an important role in their pathogenesis. They include smoking,<sup>3</sup> NSAIDs<sup>4</sup> and oral contraceptives consumption<sup>5</sup> and are associated with a high socio-economical status.<sup>6,7</sup> Appendectomy (protective for UC but not for CD)<sup>8</sup> or the occurrence of a viral gastrointestinal infection seems to also play a role in the development of these diseases. It has been long known that individuals are genetically predisposed to develop such diseases (family clustering, twins studies, ethnic groups with high prevalence).<sup>9–11</sup> Genes associated with a disease predisposition have been reported for CD.<sup>12,13</sup>

The highest IBD prevalence has always been reported in North America and Europe and few other countries such as Israel, Australia and South Africa. The prevalence tends to stabilise in North America, as suggested by the data from the Mayo Clinic in Rochester, Minnesota (USA).<sup>14–17</sup> Regarding incidence, a rise has been observed since the second half of the 20th century for both diseases, but the incidence appears now to decrease for UC while it is still slightly increasing for CD, as mainly reported in Europe.<sup>18–20</sup> Currently, although data are sparse, the IBD incidence seems to increase in Asia<sup>21,22</sup> and Central and South America<sup>23–25</sup> with a possible association to their industrialisation and changes in lifestyle.<sup>26</sup> In many populations studied, an urban-rural gradient<sup>7,15,27,28</sup> has been observed as well as, in Europe and USA, a North–South gradient.<sup>29,30</sup> However, epidemiological data collected during the nineties were influenced by many factors: among them the varying organisations of the health care system, the facilities available (endoscopy, radiology) which differ widely from one country to another, as well as the health awareness of the population.<sup>31</sup>

No study has previously evaluated the IBD prevalence in Switzerland. The sole epidemiological data available in Switzerland stemmed from a prospective study of 110 cases of CD, identified in the Basle area over a 10-year period from 1960–1969, and based only on incident cases.<sup>32</sup> At this time, no endoscopic and histological-based confirmation of the diagnosis was available. The incidence rate increased over time from 1.6 to 2.6 per 100,000 inhabitants. A prospective 9-year follow-up of these patients showed frequent relapses with or without intestinal resection and an increased risk of cancer.<sup>33</sup>

Switzerland has the advantages of its small geographic size and central location in Europe (less influence of the European North–South and East–West gradients<sup>29</sup>). It is the fifth country in Europe regarding income per capita.<sup>34</sup>

The insurance system offers all inhabitants equal access (obligatory basic insurance) to health care with a high medical density (4.6 medical doctor per 1000 inhabitants; 4th country in the world).<sup>35</sup> As health care reimbursement requires that patients seek care in their canton of residence, identification of all patients belonging to our population is largely ensured.

The aim of this study was to estimate for the first time a population-based prevalence for IBD in Switzerland and to identify factors associated with this disease. This paper presents the results of our retrospective and prospective identification of UC and CD cases in the Canton of Vaud (9% of the Swiss population), obtained by cross matching different sources (paper and computerized) of medical information. The above-described characteristics of Switzerland and its health care system make our observations well suited to represent the current situation in Western Europe.

## 2. Methods

### 2.1. Setting

Based on the 2000 Swiss census, the Canton of Vaud has a population whose age and sex distribution reflects that of Switzerland.<sup>36</sup> This population has remained stable, as global migration movement was less than 1% of the whole Canton population in 2004.<sup>37</sup> Seventy-five percent of the people reside in urban zones, which are made of 5 agglomerations around main cities of the Canton. Agglomerations are defined by the number of inhabitants, active population, economical structure and communication accesses.<sup>38</sup>

### 2.2. Case ascertainment

The diagnosis of IBD was based on the criteria established by Lennard-Jones.<sup>39,40</sup> Cases ( $\geq 20$  years old) were identified during a 18-month survey (1st July 2003–31st December 2004), based on lists pre-established by all gastroenterologists of the Canton of Vaud that included all patients seen during the preceding 12 months. Their lists were matched against lists of biopsy specimens provided by all pathology centers and further cross-matched with the results of a search by an investigator (PJ) in the gastroenterologist's computerized correspondence, using the keywords "Crohn", "colitis" and usual abbreviations to name these diseases. All gastroenterologists' offices used Microsoft® office Word software for at least 5 years, a system that permits keyword search in all free text documents. When the diagnosis remained unclear or in case of mismatch, clinical, radiological, endoscopic and histological findings were reviewed in the medical charts, during visits at the gastroenterologists' offices. Difficult cases were further discussed with the gastroenterologist in

**Table 1** Age and sex-adjusted prevalence rates of UC and CD<sup>36</sup>

Age (yr)	N (IBD)	Prevalence rate <sup>a</sup>		N (UC)	Prevalence rate <sup>a</sup>		N (CD)	Prevalence rate <sup>a</sup>	
<i>Males</i>									
20–29	71	179.2		28	70.7		43	108.5	
30–39	114	231.6		56	113.8		58	117.8	
40–49	119	240.2		76	153.4		43	86.8	
50–59	76	189.0		39	97.0		37	92.0	
60–69	57	198.9		36	125.6		21	73.3	
70–79	33	179.1		20	108.6		13	70.6	
>= 80	14	146.6		10	104.7		4	41.9	
Total	484	205.8		265	112.7		219	93.1	
Adjusted <sup>b</sup>	5771	205.8	[200.5–211.2]	3149	113.0	[109.1–117.0]	2622	92.8	[89.3–96.5]
<i>Females</i>									
20–29	52	131.4		17	43.0		35	88.5	
30–39	129	251.5		62	120.9		67	130.6	
40–49	130	263.2		57	115.4		73	147.8	
50–59	93	219.1		40	94.3		53	124.9	
60–69	65	202.8		27	84.3		38	118.6	
70–79	36	143.9		15	60.0		21	84.0	
>= 80	27	140.4		14	72.8		13	67.6	
Total	532	205.4		232	89.6		300	115.8	
Adjusted <sup>b</sup>	6206	205.3	[200.2–210.5]	2721	89.5	[86.1–92.9]	3486	115.9	[112.0–119.8]
<i>Total</i>									
20–29	123	155.3		45	56.8		78	98.5	
30–39	243	241.8		118	117.4		125	124.4	
40–49	249	251.7		133	134.4		116	117.3	
50–59	169	204.5		79	95.6		90	108.9	
60–69	122	201.0		63	103.8		59	97.2	
70–79	69	158.8		35	80.6		34	78.3	
>= 80	41	142.5		24	83.4		17	59.1	
Total	1016	205.6		497	100.6		519	105.0	
Adjusted <sup>b</sup>	11,977	205.7	[202.0–209.4]	5870	100.7	[98.2–103.4]	6108	105.0	[102.3–107.7]

<sup>a</sup> Crude rate (cases per 100,000 person years).

<sup>b</sup> Male and female rates are age adjusted to Swiss population, 2004 [95% confidence interval (CI)].

charge of the patients or with a senior IBD specialist (PM). Patients with a final diagnosis of indeterminate colitis or suspected of having another aetiology (i.e. ischemic or pseudomembranous colitis) and cases of acute colitis (less than 6 week-long) were not included in the study. Lists of patients confirmed by the investigators were sent back to the treating gastroenterologists for final agreement. The information collected for each patient included: diagnosis, age, sex and postal address. Records were anonymized when entered in the computerized database.

### 2.3. Statistical analysis

To calculate prevalence, the adult population of the canton of Vaud over 20 years of age was considered at risk for IBD. The prevalence rates were calculated by age groups and gender, based on official vital statistics for the Canton of Vaud in 2004.<sup>37</sup> Rates were then age and sex adjusted to the Swiss population and confidence intervals were computed. Socio-demographic factors that could be associated with prevalence of IBD included age, sex, geographic location

(urban versus rural), and density of population. The effects of these factors were assessed separately for UC and CD, using stepwise multivariable Poisson regression model. Relative Risk (RR) were calculated for factors that significantly ( $p < 0.05$ ) influenced the prevalence of IBD.

### 2.4. Literature review/international comparison

To compare our data with previous studies and to better characterize the change in prevalence in industrialised countries during the last four decades, an OVID search was performed on the databases MEDLINE (1966–2007), OLD MEDLINE (1950–1966), Cochrane Library 2007 (Cochrane DSR, ACP Journal Club, DARE, and CCTR), CINAHL with the MESH word Crohn's Disease/ep (subheadings Epidemiology) OR Colitis, Ulcerative/ep (subheadings Epidemiology) and epidemiology OR prevalence OR incidence as keywords. Further references were extracted from bibliographies of review articles in the field and from the referenced articles hereby. We selected studies performed in countries of high prevalence such as North America, Scandinavia and

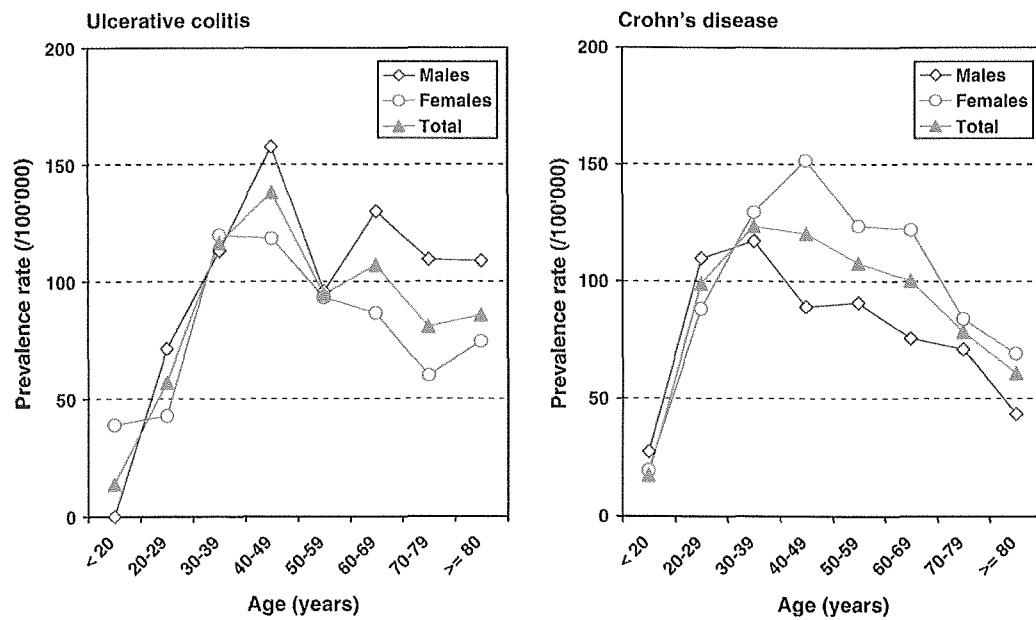


Figure 1 UC and CD prevalence by age groups and gender.

the UK, and in countries with an interesting geographical location for Switzerland (North, South and East Europe). Values of prevalence for CD and UC were extracted and classified for comparison according to the time period,

geographical location, population size and type of study. Estimated annual percent change in CD and UC prevalences were assessed, assuming a linear increase on the logarithmic scale.



Figure 2 Geographic distribution of IBD diagnosis in the canton of Vaud, Switzerland.

**Table 2** Multivariate analyses of socio-demographic factors associated with IBD

Variable	Ulcerative Colitis			Crohn's Disease		
	RR	95% CI	p-value	RR	95% CI	p-value
Males	Reference			Reference		
Females	0.80	0.67–0.95	0.013	1.27	1.07–1.51	0.007
20–29 yr	0.48	0.34–0.68	<0.001	0.79	0.60–1.05	0.102
30–39 yr	Reference			Reference		
40–49 yr	1.15	0.90–1.47	0.270	0.95	0.74–1.22	0.691
50–59 yr	0.82	0.62–1.09	0.174	0.88	0.67–1.15	0.351
60–69 yr	0.89	0.66–1.21	0.463	0.78	0.57–1.06	0.117
70–79 yr	0.70	0.48–1.03	0.067	0.62	0.43–0.91	0.015
>=80 yr	0.74	0.48–1.15	0.185	0.46	0.28–0.76	0.003
Rural zone	Reference			Reference		
Urban zone	1.63	1.29–2.07	<0.001	1.49	1.19–1.87	<0.001

## 2.5. Ethical considerations

The study was approved by the ethical committee of the University of Lausanne, Switzerland.

## 3. Results

### 3.1. Prevalence rates

Among the Canton of Vaud adult population (494,202 inhabitants), we identified 1016 cases of IBD, 519 (51%) cases of Crohn's Disease (CD) and 497 (49%) cases of Ulcerative Colitis (UC). The sex repartition was 532 women (52%) and 484 men (48%).

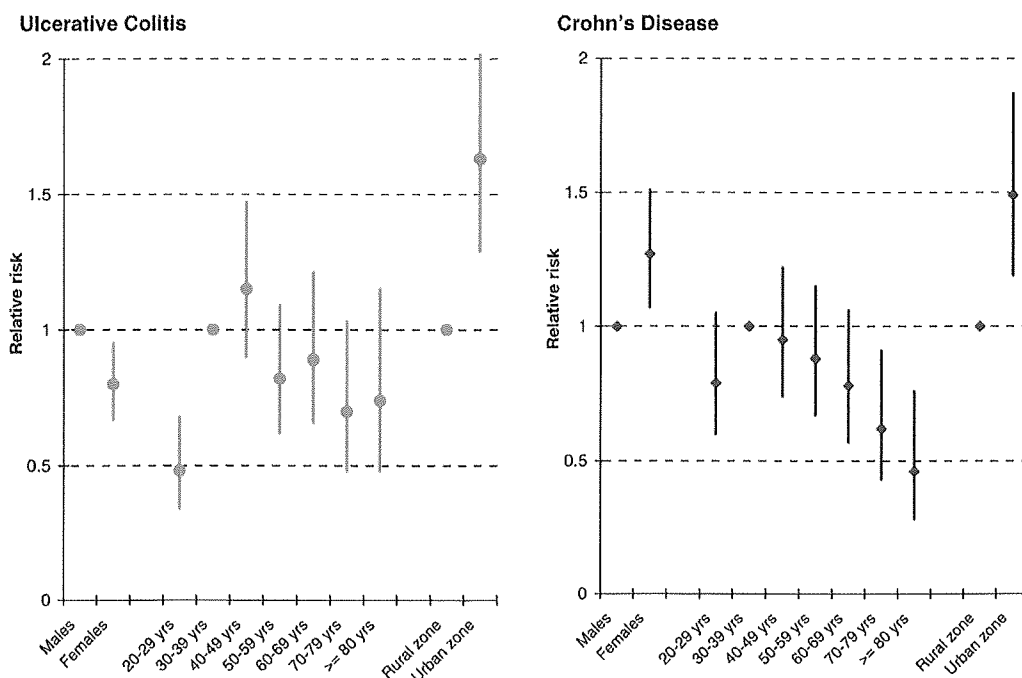
The crude prevalence rate was 205.6 IBD cases per 10<sup>5</sup> inhabitants, corresponding to 100.6 Crohn's Disease cases and 105.0 Ulcerative Colitis cases per 10<sup>5</sup> inhabitants. Age and sex-adjusted prevalence for IBD, CD and UC is given in Table 1.

### 3.2. Age stratification

The stratification by age groups (Fig. 1) showed that the highest prevalence rate for CD was found between the ages of 30 and 39 years old (124.4 cases per 10<sup>5</sup> persons), and for UC between the ages of 40 and 49 years old (134.4 cases per 10<sup>5</sup> persons), followed by a slow decline, more pronounced for CD than for UC in the later decades of life. From age 60 on, the prevalence of UC in males was higher than in females, whereas the reverse was observed for CD.

### 3.3. Geographical distribution

The geographical distribution of IBD cases in the Canton of Vaud is represented in Fig. 2, with the five agglomerations mentioned. Eighty-three percent of IBD patients were found in urban areas. The highest prevalence was found in the densest agglomeration of Lausanne with 242.9 cases per 10<sup>5</sup> persons.

**Figure 3** Multivariate analyses of socio-demographic factors associated with IBD.

**Table 3** Prevalence rates (per 100, 000 population) for Crohn's disease (CD) and Ulcerative colitis (UC)

References	Country	Year <sup>s</sup>	CD	UC	Population (inhab.)	° Study category
Juillerat et al.	Switzerland	2004	105	101	524,040	PB
<i>USA + Canada</i>						
Herrington LJ et al. [53]	USA	2001	129	191	1,800,000	HMO-B
Loftus CG et al. [17]	USA	2000	162	246	124,000	PB
Bernstein CN et al. [50]	Canada	1994	198.5	169.7	1,140,000	PB
Loftus EV et al. [14],[15]	USA	1990	144.1	229	106,000	PB
Kurata JH et al. [54]	USA	1988	25.9		652,510	HMO-B
Pinchbeck BR et al. [55]	Canada	1981	44.4	37.2	1,295,360	PB
Gollop, J. H. et al. [56]	USA	1979	90.5		90,600*	PB
Stonnington, CM. et al. [57]	USA	1979		212.6	n.a.	PB
Sedlack R.E. et al. [58]	USA	1975	105.7	117.7	89,000*	PB
Monk M et al. [59]	USA	1963		42	n.a.	HB
<i>United Kingdom</i>						
Lee FI et al. [60]	England	1997	47		300,000	HB
Rubin G. P et al. [41]	England	1994	144.8	243.4	179,496	PB
Probert, C. S. et al. [61]	England	1989	75.8	128	900,000	PB
Kyle, J. et al. [62]	Scotland	1988	147	67	509,400	HB
Fellows, IW et al. [63]	England	1985	85		215,300	PB
Jones HW et al. [64]	England	1984		70	270,000	HB
Mayberry JF et al. [65]	England	1980	55.5		130,450	HB
Devlin HB et al. [66]	England	1977	35	99	200,000	HB
Mayberry et al. [67]	Wales	1976	40.2		2,731,204	HB
Miller DS et al. [68]	England	1972	26.5		464,000	PB
Kyle, J. et al. [69]	Scotland	1969	32.5		442,000	HB
De Dombal FT et al. [70]	England	1968	25		n.a.	PB
Evans et al. [71]	England	1960	9	79.9	264,000	PB
Wright JT. et al. [72]	England	n.a.	12		n.a.	n.a.
<i>Scandinavia</i>						
Lapidus, A. [73]	Sweden	2001	213		1,470,000	PB
Lindgren, A. et al. [74]	Sweden	1990	94		331,500	PB
Munkholm P. + Langholz E. et al. [75,76]	Denmark	1987	54	161.2	554,533	PB
Tysk, C. + Lindberg, E et al. [77,78]	Sweden	1987	146	234	164,972	PB
Haug, K., E. et al. [79]	Norway	1985		92	807,000	PB
Berner, J. et al. [80]	Faroe Island	1983	31.8	157.3	44000	PB
Bjornsson, S. et al. [81]	Iceland	1979	10.7	122.2	221,854	PB
Binder, V. et al. [82]	Denmark	1978	34	117	500,000	PB
Hellers G et al. [83]	Sweden	1974	54.2		1,490,800*	PB
Bergman, L. et al. [84]	Sweden	1973	50		412,000	PB
Brahme, F. et al. [85]	Sweden	1973	75.2		251,431	PB
Bjornsson, S. et al. [81]	Iceland	1969		62.6	n.a.	PB
Brahme, F. et al. [85]	Sweden	1968		89	n.a.	PB
Bonnevie, O. et al. [86]	Denmark	1967		44.1	574,000	PB
Norlen BJ, et al. [87]	Sweden	1967	27		412,000	PB
<i>North Europe</i>						
Loeffler A. et al. [88]	Germany	1986	30.7		922,552	PB
Daiss, W. et al. [27]	Germany	1984	54.6	24.8	1,515,000	PB
Dirks, E. et al. [89]	Germany	1984		27.3	1,600,000	PB
Shivananda, S. et al. [90,91]	The Netherlands	1983	48	58.4	439,815	PB
Brandes, J. W. et al. [92]	Germany	1972	30.5	48.8	172,215	PB
<i>South Europe</i>						
Trallori G. et al. [93]	Italy	1992	40	121	540,000	PB
Alonso P. et al. [94]	Spain	1990	13	32	100,000	PB
Hinojosa, J. et al. [95]	Spain	1989	21.4	28.8	55,866	HB

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Table 3 (continued)

References	Country	Year <sup>5</sup>	CD	UC	Population (inhab.)	° Study category
<i>South Europe</i>						
Martinez-Salmeron J.F. et al. [96]	Spain	1988	9	21	>20,000	HB
Mate-Jimenez J. et al. [28]	Spain	1988	19.8	43.4	334,000	PB
<i>East Europe</i>						
Gheorghe, C. et al. [97]	Romania	2003	1.5	2.4	21,698,181	HB
Lakatos L. et al. [98]	Hungary	2001	52.9	142.6	376,000	PB
Prikazska M. et al. [99]	Slovakia	1994	6.8		n.a.	PB
Vucelic, B. et al. [100,101]	Croatia	1989	8.3	21.4	1,175,500	PB
Bitter J. et al. [102]	Czech republic	1979	12		n.a.	PB

\*Calculated values *r*.

° Study categories.

HMO: based on health maintenance organisation (HMO) registries.

HB: based on hospital registries.

PB: population-based.

n.a.: not assessed.

There was also a higher prevalence in two other urban areas with populations of more than 50,000 inhabitants, whereas in agglomerations of less than 50,000 inhabitants, the crude prevalence rate was the same as in rural regions (complementary analysis not shown).

### 3.4. Extrapolation to Switzerland

As the population of the Canton of Vaud is comparable to the general Swiss population, according to age and sex distribution, numbers of patients were extrapolated for the whole country.<sup>36</sup> Based on our observed values, we estimate that about 12,000 persons suffer from IBD (6100 from CD and 5900 from UC) in Switzerland.

### 3.5. Socio-demographic factors associated with prevalence

A multivariable Poisson regression analysis was performed to determine the association between relevant socio-demographic factors available for the population of the Canton of Vaud and IBD prevalence. Results are shown in Table 2 and Fig. 3. Factors

associated with UC were being a male (Relative Risk (RR) 1.25; 95% confidence interval (CI), 1.05–1.49;  $p=0.013$ ) and living in an urban zone (RR 1.63; 95% CI, 1.29–2.07;  $p<0.001$ ), whereas being a female (RR 1.27; 95% CI, 1.07–1.51;  $p=0.007$ ) and living in an urban zone (RR 1.49; 95% CI, 1.19–1.87;  $p<0.001$ ) were associated with CD. The association with age was different for UC and CD. The RR for UC doubled for people between 30–39 years of age as compared to those ten years younger ( $p<0.001$ ) and peaked in the 40–49 age group. The prevalence of CD was maximal in the 30–39 year old age group, then diminished gradually with age. From the age of 70 years, the prevalence was significantly lower than between 30 and 39 years of age.

### 3.6. Medical density, health consumption and diagnosis delay

A univariate analysis showed that the medical density was to some extent related to the number of IBD diagnoses. From two general practitioners per thousand inhabitants or one gastrointestinal specialist per district, the IBD prevalence did not further increase with denser medical coverage.

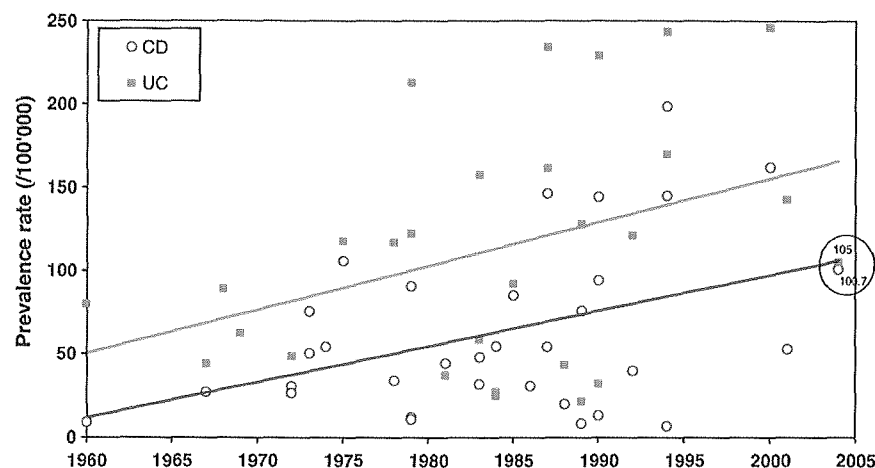


Figure 4 Time trends in CD and UC prevalences in selected population-based studies.

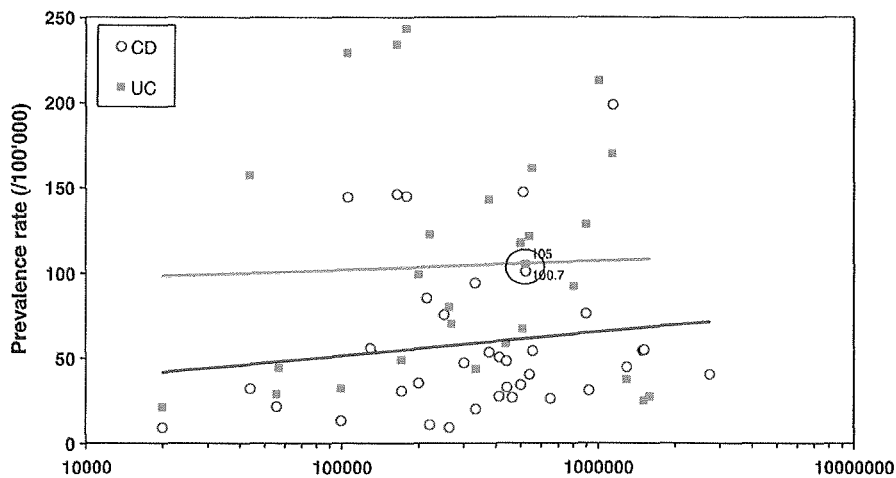


Figure 5 CD and UC prevalence according to population size (log scale) in selected population-based studies.

### 3.7. Literature review

Six hundred seventy articles were identified from 1966 till June 2007, then imported to a references database (Endnote®) for a manual selection. However, most epidemiological articles that were retained were issued from a manual search in the bibliography of selected articles. During this process, articles were excluded if they were only considering incidence or other epidemiological themes that differ from prevalence. Table 3 gives details on prevalence data, time period, type of study and population size of 57 epidemiological studies on IBD prevalence in Europe and North America. The prevalences found in these population-based or hospital-based studies ranged from 2 to 213 CD patients per  $10^5$  inhabitants and from 2 to 246 UC patients per  $10^5$  inhabitants. Most studies directly used health maintenance organisation (HMO) registries, hospital registries or medical records to calculate the prevalence. The last study that analyzed retrospectively medical records was made in 1997.<sup>41</sup> Other studies were based on the identification of incident IBD cases, with durations that were considered sufficient to extrapolate prevalence values. The most recent updated study of this category comes from the Olmsted County in 2006.<sup>17</sup> Plotting data from population-based studies similar to our study (USA, UK, Scandinavia, North and South Europe) over time, we observed between 1960 and 2005, an annual increase of IBD prevalence of 2.4% (95%CI, 2.1%–2.8%) and 3.6% (95%CI, 3.1%–4.1%) for UC and CD, respectively (Fig. 4). This increase was statistically significant in both cases. Prevalence for Switzerland was in line with the international trend for CD, but was lower for UC. A representation of the prevalence values according to population size showed little influence of the size of the population studied on the prevalence rates, which were globally higher for UC than CD (Fig. 5).

## 4. Discussion

This first population-based study undertaken in Switzerland enables the identification of more than one thousand IBD patients at the end of 2004 in the Canton of Vaud, with an equal distribution between UC and CD cases. The prevalence rates were for UC 105.0 and for CD 100.7 patients per  $10^5$

inhabitants. If our results are extrapolated to the whole country, more than twelve thousand people suffer from IBD in Switzerland.

There were several strengths in our study. Firstly, the population size (half a million inhabitants), its stability and a good and uniform access to health care. Indeed, we observed that patients had the same likelihood to be diagnosed with IBD in each district of our study area. Secondly, geographic location of Switzerland in the middle of Europe makes our country “representative” for epidemiological studies without being affected by a North–South or West–East gradient.

The main limitation of this study was the confinement to adult individuals (over 20 years old) followed by gastroenterologists. Notwithstanding, our independent sources of data (gastroenterologists, pathologists, hospitals) presented a sufficient overlap to be confident that our study comprehensively covered the population under scrutiny. This is supported by a recent study that showed the central role of gastroenterologists in the management of IBD patients in Switzerland.<sup>42</sup>

The age-adjusted prevalence of IBD in our study was comparable to the rates reported in Europe and North America over the last twenty years. Our values, when compared with prevalences in other population-based studies were lower than the most recent values found in North America, in United Kingdom and in Scandinavia, but two to fivefold larger than rates from South and East Europe (Table 3). They were also doubled in comparison with data from population-based studies made between the end of the eighties and the beginning of the nineties in the closest geographical countries (Italy, Germany and the Netherlands). This might suggest a persistent annual increase of prevalence of both diseases, which seems to be more important for CD than for UC over the last 45 years. However it is not possible to know if the prevalence increase remains actually at the same level as calculated here in the previous decades, but further analysis did not identify any plateau phase as described for the incidence in some countries.<sup>18–20,43</sup>

We observed a higher prevalence of CD than UC, as was also reported in two neighboring countries, Germany<sup>27</sup> and, indirectly, France (“Franco–Belge exception”).<sup>44–48</sup> We found that the prevalence of CD, but not of UC, was substantially higher among females ( $p < 0.001$ ), in keeping with

previous studies.<sup>18,49–51</sup> We observed a slight male predominance of UC over age 50 (Fig. 2) that confirmed longstanding observations from the Mayo clinic (Olmsted County, Minnesota USA).<sup>15</sup> Our cohort has a remarkably low proportion of CD patients over 60 years old. We believe that it could be in part due to an increased mortality in CD patients, in particular with an age above 40 years at diagnosis, as described in a recent population-based cohort.<sup>52</sup>

In our cohort, living in an urban area was an important and independent socio-demographic factor associated with IBD. Many previous studies described an urban-rural gradient.<sup>7,15,27,28</sup> An analysis of smoking habit in IBD patients showed no difference between rural and urban areas (own data, not published). There was also no significant difference with the general population, but data are lacking to clarify if tobacco consumption is an environmental factor associated with the population density. Other environmental factors need to be further studied to determine their contribution to the variation in prevalences which is only partly explained by the above mentioned factors.

In conclusion, our study estimates that 0.2% of the Swiss adult population suffers from IBD. On the basis of these values and the perception of an increase of both UC and CD prevalences supported by our detailed analysis of published data, we emphasize the importance to start up prospective cohorts to evaluate direct and indirect costs of IBD for the society.

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