

Inflammatory bowel disease: gender difference

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Summary. Inflammatory bowel diseases (IBDs) are chronic, relapsing inflammatory diseases characterized by exacerbations and remissions of the gastrointestinal tract, clinically manifested as Crohn's disease and ulcerative colitis. The etiology of IBDs is considered to be multifactorial, comprising environmental, immune, microbial and genetic factors. Clinical signs may include abdominal pain, frequent bloody diarrheas, mucorrhea, vomiting, fever, fatigue or weight loss. Males and females have a different predisposition for the development of intestinal disorders, like the inflammatory bowel disease. This review paper discusses the difference of gender in inflammatory bowel disease. Gender medicine has allowed, in recent years, to solve many diagnostic and therapeutic problems of female and male health.

Key words: gender difference, inflammatory bowel disease, immune system.

Le differenze di genere nelle malattie infiammatorie croniche intestinali

Riassunto. Le malattie infiammatorie croniche intestinali (MICI), rappresentate dalla colite ulcerosa e dalla malattia di Crohn, sono caratterizzate da periodi di remissione alternati a recidive. L'eziologia è multifattoriale e include fattori ambientali, immunitari, genetici e alterazioni della flora batterica. La sintomatologia è caratterizzata da dolori addominali, diarrea muco sanguinolenta, vomito, febbre, astenia e perdita di peso. I due sessi hanno una differente predisposizione allo sviluppo di alcuni disordini intestinali come le malattie infiammatorie croniche. Questa review affronta le problematiche relative alle differenze di genere nelle MICI. La medicina di genere, negli ultimi anni, ha permesso di risolvere molti problemi diagnostici e terapeutici della salute della donna e dell'uomo.

Parole chiave: differenze di genere, malattie infiammatorie croniche intestinali, sistema immunitario.

Introduction

Inflammatory bowel disease (IBD) is a multifactorial disorder encompassing two major diseases, ulcerative colitis (UC) and Crohn's disease (CD)¹. An imbalance of the interaction among immune system, enteric anti-

gens and intestinal mucosa results in a chronic, immune-mediated inflammation².

IBDs are associated with several gastrointestinal (GI) symptoms that can differ widely in severity of presentation and can include the following: abdominal pain, diarrhea, GI bleeding, intestinal fistula, intra-abdominal abscess and anal disease³. IBDs can also present a large number of extra intestinal manifestations (EIMs) with involvement of the musculoskeletal, cutaneous, hepatobiliary and ocular systems⁴. Diagnosis of IBDs is based on the correlation of clinical, radiological, endoscopic and histopathological findings⁵.

Estimated incidence is 10-15 new cases/100,000 inhabitants/year (9-12%) and prevalence is about 0.2 to 0.4%. Crohn's disease and Ulcerative colitis have a peak incidence between the second and third decade of life and more rarely around the sixth decade⁶. IBDs generally occur with similar frequency in men and women and can be a debilitating illness with significant impact on the quality of life⁷. Susceptibility to develop inflammatory bowel disease (IBD), such as Crohn's disease, could depend on factors related to gender differences. In Asian countries, men have a higher incidence of the disease (considering data from studies conducted in Asia and Middle East) whereas in European countries there is a moderate female predominance^{8,9,10}.

Although IBDs have been traditionally considered characteristic of Western industrialized countries, their incidence and prevalence have increased rapidly across Asia in the last two decades¹¹. The change in the epidemiology seems to be related to westernization of lifestyle and environmental factors. However, different genetic factors may be involved in the pathogenesis with the NOD2/CARD15 mutations, characteristics of White and Jewish population, being less common. Instead, variations in the tumor necrosis factor superfamily member 15 (TNFSF15) seems to be associated with Asian populations¹². TNFSF15 is a member of the TNF cytokines family and is expressed in endothelial cells but its role is not completely understood. Some studies demonstrated that TNFSF15 polymorphism is associated with CD in Japanese and Koreans^{13,14}.

Male predominance in the incidence of Crohn's disease in Asian countries is not completely understood; it

could be partly explained by the differential rates of cigarette smoking in this group of patients. This data is highlighted in a population-based study conducted by members of the Korean Association for the Study of Intestinal Diseases (KASID) in a district of Seoul, Korea, from 1986 to 2005¹⁵. During this period, 138 new cases of CD were diagnosed, 102 men and 36 women. The male predominance was observed for CD but not for UC (341 patients, 170 men and 171 women). These findings have been observed also in Japan and Hong Kong^{16,17}. The difference in the smoking rates might justify this data but it is not sufficient to completely explain it; since in the KASID study the male-to-female ratio for UC was 1:1, other factors could be involved. Sex-related differences or predisposing factors should be investigated for a better comprehension of IBD etiology¹⁵.

Despite other diseases, such as cardiovascular diseases, autoimmune connective tissue disorders, diabetes and cancer, data about gender-related differences in the management of IBD are lacking¹⁸.

Immune system

The immune system seems to play an important role in the development and progression of IBDs¹⁹. Numerous epidemiological, clinical and experimental studies have shown significant differences between women and men in the immune response.

Females have a higher risk of developing autoimmune diseases such as rheumatoid arthritis and systemic lupus erythematosus than males²⁰. Differences in peripheral immune responses can explain the increased risk of autoimmune diseases²¹. Females generally have a more vigorous adaptive immune response, whereas males have increased innate immune response²². It was hypothesized that sex differences in IBD may be due to a different intestinal immune response²³. The intestinal immune system, defined as gut-associated lymphoid tissue (GALT), is in close contact with intestinal microbes and dietary antigens, and work in a different manner with respect to the peripheral immune system²⁴. The main challenge of the GALT is to distinguish harmless from harmful antigens and to respond appropriately. The GALT consists of immune cells scattered throughout the lamina propria and organized lymph structures like the Peyer's patches (PP) and mesenteric lymph nodes (MLN)²⁵. Dendritic cells (DCs) in the PP that express integrin sub-unit CD103 are able to differentiate T helper (Th) cells into FoxP3⁺ T regulatory cells (Tregs)^{26,27}. Tregs can produce IL-10 and are important in controlling T helper responses and in preventing inflammation. Both CD103⁺ DCs and Tregs play an important role in intestinal homeostasis and tolerance and in the prevention of IBD²⁸. Other immune cells that play a role in

intestinal homeostasis are natural killer (NK) cells. NKp46⁺ NK cells co-expressing transcription factor ROR γ t in the intestine can produce interleukin 22 (IL-22)²⁹, which is involved in regulating mucosal barrier homeostasis and antimicrobial host defense³⁰. Whether these intestinal immune cell subsets are sex dependent is still to be determined.

Gender issues

Different aspects have been addressed regarding the impact of gender on characteristics, phenotypes, management and outcome of IBD patients, since sexual differences could influence disease presentation, prognosis and treatment. As far as the natural history is concerned, male gender seems to be associated with a more severe disease, but data are still controversial⁸. The same consideration should be applied for surgery. While observational studies report an increased risk for surgery in men, in a retrospective study a higher rate of ileo-colocolic resection in female patient with CD³¹ was noted. The risk of colon-rectal cancer (CRC), as long-term complication, is higher in male IBD patients due to biological and behavioral factors; however the exact mechanisms are not fully understood. Indeed increased mortality from CRC has been observed in men⁸.

In addition, the association between IBD and extra intestinal manifestations (EIMs) is well established, in particular musculoskeletal, mucocutaneous and ocular. The prevalence ranges from 16% to 40% of patients with IBD but this value depends on the definition considered. The pathogenesis is largely unknown, but environmental factors such as smoking, autoimmune disorders and genetic mutations are thought to be involved. Patients can experiment EIMs during the course of CD or UC but the development of these disorders can also precede IBD diagnosis by several years. Data on epidemiology, risk factors and gender differences are limited. A recent Greek multicenter study on a large cohort of IBD patients highlighted a positive association between active disease and EIMs (61.1% of patients) and a female prevalence; indeed the latter resulted statistically significant in multivariate analysis³². Other studies described this increased prevalence in females³³ due to altered hormone and autoimmune patterns³⁴, however the results are controversial³⁵. In general, the female gender is associated with eye and skin disorders, meanwhile in men primary sclerosing cholangitis and ankylosing spondylitis are more frequent⁸.

Some aspects are related to the experience of a bad perception of body image and sexuality.

Women with IBD, who use tobacco, are immunosuppressed and those which were diagnosed with IBD at an early age may be at an increased risk for cervical dysplasia and should be screened^{36,37}.

Men and women with IBD generally have preserved fertility but have fewer children due to voluntary childlessness. However, certain subgroups of men and women may be at a higher risk for infertility. Men on therapy with certain immunosuppressive medications and women after ileal pouch-anal anastomosis (IPAA) can have infertility³⁸. Despite reports of sexual dysfunction in men and women after IPAA, both sexes report improved sexual satisfaction postoperatively. Pregnancy in women with IBD should be planned, and contraceptive choice should be individualized. Women with IBD reach menopause at similar rates as those of the general population and do not experience change in post menopause disease activities^{39,40}.

Low bone mineral density (BMD) is more common in both men and women with IBD compared with the general population, and most patients with IBD should be screened with dual-energy X-ray absorptiometry (DEXA) scans⁴¹.

As more is learned regarding the physical and psychosocial effects of IBD and its treatment, it has become clear that men and women face unique challenges. IBD may affect patients' physical appearance due to fistulae, surgical scarring, and/or ostomy placement. In addition, patients with IBD often suffer from abdominal pain, diarrhea, and fecal incontinence, which have the potential to affect both body image and sexuality. Some patients, especially women and postoperative patients, may be at a greater risk for impaired body image. In a survey-based study of more than 200 patients with IBD, almost 70% of patients reported impaired body image, and this appeared to affect women more than men (75% vs 51% prevalence of impaired body image in women and men, respectively) and operated patients more than non operated patients (81% vs 51%, respectively). Female gender and operated condition are also associated with impaired sexuality. In the same study, women and operated patients reported significantly decreased sexual activity due to IBD than their male and non operated counterparts (66% vs 41% prevalence of decreased sexual activity in women and men, respectively, and 69% vs 50% prevalence of decreased sexual activity in operated vs non operated patients, respectively). A second interview-based study further investigated the origins of impaired sexual function in women with CD. When women were asked why they avoided intercourse, the most common reasons were abdominal pain, diarrhea and fear of fecal incontinence. A significant proportion of women also reported dyspareunia.

Psychosocial factors are also a significant contributor to impaired sexuality; research has shown that a depressed mood is the strongest and most consistent risk factor for low sexual function in IBD patients⁴².

Effect of smoking on genders in Crohn's disease

In 1982 the relation between smoking and IBD was highlighted for the first time thanks to a British case control study performed by Harris: among the patients affected by UC it was noticed that there was only a low percentage of smokers. Later several studies well established that cigarette smoking is a crucial environmental factor in the course of IBD, however it has two opposite effects on UC and Crohn's disease⁴³. The reasons underlying this divergent impact remain largely obscure but probably depend on several factors including the direct effects of tobacco components on the immune system (innate and acquired), microvasculature and microbiota⁴⁴.

In ulcerative colitis, tobacco seems to have a beneficial and protective effect: the risk of development of the disease is lower in smoking patients compared with lifetime non smokers⁴⁵, the corticosteroid utilization is reduced as well as the risk of colectomy (smoking is associated with higher disease-related costs and lower health-related quality of life in IBD) and in general the course is more benign. Moreover, stopping smoking leads to an increased risk of developing UC and it is associated with a worse disease activity, both in men and women without any sex differences⁴³.

On the contrary, smoking has a deleterious effect on the course of the CD. The smoke exposure appears to be one of the environmental factors that contribute to gender differences in CD. It also appears that smoking could determine the location of the disease, with a higher prevalence of ileal disease and a lower prevalence of colonic involvement⁴³. The females who smoke would develop an early onset disease and a more severe form compared with men. The precise mechanism responsible for the gender differences in the CD is not yet known. It is believed that cigarette smoking strongly influences the humoral and cell-mediation, even leading to the release and inhibition of various pro- and anti-inflammatory mediators⁴⁶. It seems that the molecular mechanism is at least partially responsible for the immunomodulatory properties of smoking, involving the activation of the kinase inhibitor I κ B (IKK), phosphorylation of I κ B (inhibitor of nuclear factor NF- κ B), NF- κ B nuclear translocation and histone acetylation⁴⁷. NF- κ B is a key transcription factor regulating the expression of various proinflammatory cytokines and numerous studies have linked its activation to elevated cytokine expression in smokers⁴⁸. Other transcriptional factors related to smoking have been identified so far, including GATA, PAX5, Smad 3/4, AP-1, ISRE, ICSBP^{46,47}.

There is evidence to support the idea that women are more vulnerable to the effects of smoking with an easier rupture of immune balance, which results in a significant increase in the production of IFN- γ , not accompanied by the release of Th2 cytokines^{47,49}. Some possible explanations for this phenomenon are the negative

effects of estrogens on proinflammatory cytokine gene regulation and interactions of immune cells⁵⁰ or the differences between genders in smoking habits, since females use more filter cigarettes and lighter cigarettes, resulting in a relatively greater exposure to nicotine⁵¹.

Therapy

There is little information in the literature on the use of sulfasalazine in the treatment of IBD that prove its negative effect on fertility in men, but not women⁵². The effects of sulfasalazine on sperm count, motility, and morphology are reversible after drug withdrawal.

In rat models, corticosteroids have been shown to decrease fertility in men, but not in women, while 5-aminosalicylic acid agents, 6-mercaptopurine, azathioprine, and biologic agents have not been shown to affect fertility in men or women, although it should be noted that researches on fertility and biologic agents have been limited to animal studies⁵³.

Currently there are not many studies on the differences in the treatment of IBD in the two sexes, often because they are women of child bearing age and/or pregnancy; indeed the results are contradictory.

A cohort study carried out in a metropolitan area of Germany showed that women had an infrequent use of immunosuppressive agents compared to men. This finding is probably related to the lower rate of remission in women than men, especially in patients with UC⁵⁴. In men there is an increased risk of developing a more serious illness and, as they have lower adherence to treatment with corticosteroids and/or aminosalicylates, the use of these drugs takes place earlier. In women of child-bearing age there is a low tendency to use these drugs. According to the current "step-up" approach in the medical management of IBD, these results could explain the more common use of immunosuppressive drugs in males. So, as immunosuppressive drugs are more effective than aminosalicylates, remission rates appear higher among male patients⁵⁵.

Furthermore, it appears to be unreasonable to believe that gender-related adherence to various drugs utilized in IBD may be different. In favor of the latter assumption Mantzaris et al. reported that male gender was associated with non-adherence of treatment with AZA in patients with CD in long-term remission⁵⁶. However these patients showed a short term remission of the disease and a quality of life that did not differ significantly from patients who were adherent to treatment. So, if there was female predominance in medical adherence to treatments, this appears not to be influencing the better outcome of women compared to men. Other studies need to clarify this relationship among adherence, gender and outcome of the disease.

As already pointed out, the lower use of immunosuppressive therapy in females could also be explained by the uncertainties in the prescription for women of child-bearing age. However, an age-related analysis (women age 18–42 vs >42 years) did not reveal any difference in the treatment of women in either CD or UC between both age groups. A therapy with AZA/6-MP, the most commonly used immunosuppressive drug in IBD, is generally considered to be of low risk during pregnancy^{57, 58}.

AZA and 6MP may have effects on the fetus when used by men within three months from conception, while the metrotrexate (MTX) is an absolute contraindication for men and for women before conception and during pregnancy. Zelinkova et al. in a study of a cohort of 61 IBD patients (51 females, 40 with CD, 21 with UC) showed that about one-third changed the medication due to active reproductive plans⁵⁹. In a review article that analyzes reproduction in IBD the authors underline that the risk of complications during pregnancy seems to be primarily related to disease activity and not to specific medications, but the argument remains controversial because the literature comes from retrospective studies⁶⁰.

Regarding biological agents, Lesuis et al performed an observational study to analyze gender differences in biological treatments in three different immune-mediated diseases: IBD, psoriasis and rheumatoid arthritis. 131 IBD patients were included and received anti-TNF- α (infliximab) as their first biologic; disease characteristics and activity were examined at the beginning of the treatment at a single time point, according to clinical and laboratory parameters. Men and women presented similar disease severity at the treatment start but female patients experienced more symptoms. Women showed higher scores than men on subjective, but not objective, disease activity measures, therefore it is assumed that the disease has a greater effect in women⁶¹.

In conclusion, few data regarding the influences of gender on IBD are available in the literature. To get more information, it will be necessary to carry out further trials that include an equal number of men and women. Data from genetic and metabolic studies need to clarify some aspects, however the efficacy of drugs should also be explored in some physiological conditions, such as fertility period and pregnancy.

References

- Burisch J, Munkholm P. The epidemiology of inflammatory bowel disease. *Scand J Gastroenterol* 2015; 50(8): 942-51.
- Braus NA, Elliott DE. Advances in the pathogenesis and treatment of IBD. *Clin Immunol* 2009; 132(1): 1-9.
- Dogan B, Scherl E, Bosworth B, et al. Multidrug resistance is common in *Escherichia coli* associated with ileal Crohn's disease. *Inflamm Bowel Dis* 2013; 19: 141-50.
- Levine JS, Burakoff R. Extraintestinal manifestations of inflammatory bowel disease. *Gastroenterol Hepatol (N Y)* 2011; 7(4): 235-41.
- Ji Min Lee and Kang-Moon Lee. Endoscopic diagnosis and differentiation of inflammatory bowel disease. *Clinical Endoscopy* 2016; 49(4): 370-5.
- Abraham C, Cho JH. Inflammatory bowel disease. *N Eng J Med* 2009; 361: 2066-78.
- Lopez Cortes R, Marin Fernandez B, et al. Quality of life in patients with inflammatory bowel disease. *An Sist Saint Navar* 2016; 39(1): 123-31.
- Zelinkova Z, der Woude CJ. Gender and inflammatory bowel disease. *J Clin Cell Immunol* 2014; 5: 245.
- Molodecky NA, Soon IS, Rabi DM, et al. Increasing incidence and prevalence of the inflammatory bowel diseases with time, based on systematic review. *Gastroenterology*. 2012; 142: 46-54.
- Maloy KJ, Powrie F. Intestinal homeostasis and its breakdown in inflammatory bowel disease. *Nature* 2011; 474: 298-306.
- Prideaux L, Kamm MA, De Cruz PP, Chan FK, Ng SC. Inflammatory bowel disease in Asia: a systematic review. *J Gastroenterol Hepatol* 2012; 27(8): 1266-80.
- Thia KT, Loftus EV Jr, Sandborn WJ, Jang SK. An update of epidemiology of inflammatory bowel disease in Asia. *Am J Gastroenterol* 2008; 103(12): 3167-82.
- Yamazaki K, McGovern D, Ragoussis J, et al. Single nucleotide polymorphisms in TNFSF15 confer susceptibility to Crohn's disease. *Hum Mol Genet* 2005; 14:3499-506.
- Yang SK, Lim J, Chang HS, et al. Association of TNFSF15 with Crohn's disease in Koreans. *Am J Gastroenterol* 2008; 103: 1437-42.
- Yang SK, Yun S, Kim JH, et al. Epidemiology of inflammatory bowel disease in the Songpa-Kangdong district, Seoul, Korea, 1986-2005: a KASID study. *Inflammatory Bowel Diseases* 2008; 14 (04): 542-9.
- Yao T, Matsui T, Hiwatashi N. Crohn's disease in Japan: diagnostic criteria and epidemiology. *Dis Colon Rectum* 2000; 43 (10 Suppl): S85-93.
- Leong RW, Lau JY, Sung JJ. The epidemiology and phenotype of Crohn's disease in the Chinese population. *Inflamm Bowel Dis* 2004; 10(5): 646-51.
- Oertelt-Prigione S. The influence of sex and gender on the immune response. *Autoimmun Rev* 2012; 11(6-7): A479-85.
- Beeson PB. Age and sex associations of 40 autoimmune diseases. *Am J Med* 1994; 96: 457-62.
- Cutolo M, Capellino S, Sulli A, Seriola B, Secchi ME, Villaggio B, Straub RH. Estrogens and autoimmune diseases. *Ann N Y Acad Sci* 2006;1089: 538-47.
- Bouman A, Schipper M, Heineman M, Faas M. Gender difference in the non-specific and specific immune response in humans. *Am J Reprod Immunol* 2004; 52: 19-26.
- Khein Sabra L, Flanagan Katie L. Sex differences in immune response. *Nature Rev Immunology* 2016; 16: 626-38.
- Hooper LV, Macpherson AJ. Immune adaptations that maintain homeostasis with the intestinal microbiota. *Nat Rev Immunol* 2010; 10: 159-69.
- Mowat AM. Anatomical basis of tolerance and immunity to intestinal antigens. *Nat Rev Immunol* 2003; 3: 331-41.
- Jung C, Hugot JP, Barreau F. Peyer's patches: the immune sensor of the intestine. *Int J Inflam* 2010: 823710.
- Coombes JL, Siddiqui KRR, Arancibia-Carcamo CV, et al. A functionally specialized population of mucosal CD103(+) DCs induces Foxp3(+) regulatory T cells via a TGF-beta- and retinoic acid-dependent mechanism. *J Exp Med* 2007; 204: 1757-6.
- Iliev ID, Mileti E, Matteoli G, Chieppa M, Rescigno M. Intestinal epithelial cells promote colitis-protective regulatory T-cell differentiation through dendritic cell conditioning. *Mucosal Immunol* 2009; 2: 340-50.
- Bollrath J, Powrie FM. Controlling the frontier: regulatory T-cells and intestinal homeostasis. *Semin Immunol* 2013; 25: 352-7.
- I Kaiko GK, Horvat JC, Beagley KW, Hansbro PM. Immunological decision-making: how does the immune system decide to mount a helper T-cell response? *Immunology* 2007; 123: 326-38.
- Sonnenberg GF, Fouser LA, Artis D. Border patrol: regulation of immunity, inflammation and tissue homeostasis at barrier surfaces by IL-22. *Nat Immunol* 2011; 12: 383-90.
- Wagtman MJ, Versapaget HW, Lamers CB, van Hogezaand RA. Gender-related differences in the clinical course of Crohn's disease. *Am J Gastroenterol* 2001; 96: 1541-6.
- Karmiris K, Avgerinos A, Tavernaki A, et al. Prevalence and characteristics of extra-intestinal manifestations in a large cohort of Greek patients with inflammatory bowel disease. *J Crohns Colitis* 2016; 10(4): 429-36.

Key messages

- Several studies showed that females have a higher risk of developing autoimmune diseases. Gender can influence immune response in IBD.
- Smoking has a deleterious effect on the course of Crohn disease. The females who smoke would develop an early onset of the disease and a more severe form compared to men. Exposure to smoke appears to be one of the environmental factors that contribute to gender differences in Crohn disease.
- Men and women with IBD generally have preserved fertility but have fewer children due to voluntary childlessness.
- Men on therapy with certain immunosuppressive medications and women after ileal pouch-anal anastomosis can have infertility often related to impaired sexual function.
- Complications of IBD during pregnancy seem to be primarily related to disease activity and not to a specific medication.

33. Vavricka SR, Brun L, Ballabeni P, et al. Frequency and risk factors for extraintestinal manifestations in the Swiss inflammatory bowel disease cohort. *Am J Gastroenterol* 2011; 106: 110-9.
34. Bernstein CN, Blanchard JF, Rawsthorne P, Yu N. The Prevalence of Extraintestinal Diseases in Inflammatory Bowel Disease: A Population-Based Study *Am J Gastroenterol* 2001; 96: 1116-22.
35. Isene R, Bernklev T, Høie O, et al.; EC-IBD Study Group. Extraintestinal manifestations in Crohn's disease and ulcerative colitis: results from a prospective, population-based European inception cohort. *Scand J Gastroenterol* 2015; 50: 300-5.
36. Borum ML, Igiehon E, Shafa S. Physicians may inadequately address sexuality in women with inflammatory bowel disease. *Inflamm Bowel Dis* 2010; 16(2): 181.
37. Klumb EM, Araújo ML, Jr, Jesus GR, et al. Is higher prevalence of cervical intraepithelial neoplasia in women with lupus due to immunosuppression? *J Clin Rheumatol* 2010; 16(4): 153-7.
38. Abitbol V, Roux C, Guillemant S, et al. Bone assessment in patients with ileal pouch-anal anastomosis for inflammatory bowel disease. *Br J Surg* 1997; 84(11): 1551-4.
39. Lichtarowicz A, Norman C, Calcraft B, Morris JS, Rhodes J, Mayberry J. A study of the menopause, smoking, and contraception in women with Crohn's disease. *QJ Med* 1989; 72(267): 623-31.
40. Kane SV, Reddy D. Hormonal replacement therapy after menopause is protective of disease activity in women with inflammatory bowel disease. *Am J Gastroenterol* 2008; 103(5): 1193-6.
41. Bernstein CN, Leslie WD, Leboff MS. AGA technical review on osteoporosis in gastrointestinal diseases. *Gastroenterology* 2003; 124(3): 795-84.
42. Moody G, Probert CS, Srivastava EM, Rhodes J, Mayberry JF. Sexual dysfunction amongst women with Crohn's disease: a hidden problem. *Digestion* 1992; 52(3-4): 179-83.
43. Cosnes J. What is the link between the use of tobacco and IBD? *Inflamm Bowel Dis* 2008; (14 Suppl): S14-5.
44. Parkers JC, Whelan K, Lindsay JO. Smoking in inflammatory bowel disease: impact on disease course and insights into the etiology of its effect. *J Crohns Colitis* 2014; 8(8): 717-25.
45. Karczewski J, Poniedziałek B, Rzymiski P, et al. The effect of cigarette smoking on the clinical course of inflammatory bowel disease. *Prz Gastroenterol* 2014; 9(3): 153-9.
46. Arnson Y, Shoenfeld Y, Amital H. Effects of tobacco smoke on immunity, inflammation and autoimmunity. *J Autoimmun* 2010; 34: J258-65.
47. Hasnis E, Bar-Shai M, Burbea Z, Reznick AZ. Mechanisms underlying cigarette smoke-induced NF-kappaB activation in human lymphocytes: the role of reactive nitrogen species. *J Physiol Pharmacol* 2007; 58: 275-87.
48. Gonçalves RB, Coletta RD, Silvério KG, et al. Impact of smoking on inflammation: overview of molecular mechanisms. *Inflamm Res* 2011; 60: 409-24.
49. Whetzel CA, Corwin EJ, Klein LC. Disruption in Th1/Th2 immune response in young adult smokers. *Addict Behav* 2007; 32(1):1-8.
50. Rider V, Abdou NI. Gender differences in autoimmunity: molecular basis for estrogen effects in systemic lupus erythematosus. *Int Immunopharmacol* 2001; 1: 1009-24.
51. Zeman MV, Hiraki L, Sellers EM. Gender differences in tobacco smoking: higher relative exposure to smoke than nicotine in women. *J Womens Health Gend Based Med* 2002; 11: 147-53.
52. Bermas BL, Hill JA. Effects of immunosuppressive drugs during pregnancy. *Arthritis Rheum* 1995; 12: 1722-32.
53. Ediger JP, Walker JR, Graff L, et al Predictors of medication adherence in inflammatory bowel disease. *Am J Gastroenterol* 2007; 7: 1417-26.
54. Ott C, Obermeier F, Thieler S, et al. The incidence of inflammatory bowel disease in a rural region of Southern Germany: a prospective population-based study. *Eur J Gastroenterol Hepatol* 2008; 9: 917-23.
55. Blumenstein I, Bock H, Zosel C, et al. Are there gender-related differences in the therapeutic management of patients suffering from inflammatory bowel disease? Subgroup analysis of a prospective multicentre onlinebased trial. *Z Gastroenterol* 2009; 47(10): 1045-51.
56. Mantzaris GJ, Roussos A, Kalantzis C, Koilakou S, Raptis N, Kalantzis N. How adherent to treatment with azathioprine are patients with Crohn's disease in long-term remission? *Inflamm Bowel Dis* 2007; 4: 446-50.
57. Willis FR, Findlay CA, Gorrie MJ, Watson MA, Wilkinson AG, Beattie TJ. Children of renal transplant recipient mothers. *J Paediatr Child Health* 2000;3:230-5.
58. Roubenoff R, Hoyt J, Petri M, Hochberg MC, Hellmann DB. Effects of antiinflammatory and immunosuppressive drugs on pregnancy and fertility. *Semin Arthritis Rheum* 1988; 2: 88-110.
59. Zelinkova Z, Mensink PB, Dees J, Kuipers EJ, van der Woude CJ. Reproductive wish represents an important factor influencing therapeutic strategy in inflammatory bowel diseases. *Scand J Gastroenterol* 2010; 1: 46-50.
60. Heetun ZS, Byrnes C, Neary P, O'Morain C. Review article: reproduction in the patient with inflammatory bowel disease. *Aliment Pharmacol Ther* 2007; 26(4): 513-33.
61. Lesuis N, Befrits R, Nyberg F, van Vollenhoven RF. Gender and the treatment of immune-mediated chronic inflammatory diseases: rheumatoid arthritis, inflammatory bowel disease and psoriasis: an observational study. *BMC Med* 2012; 10: 82.

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