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Genetic Epidemiology and Heritability of Vitiligo

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1. Introduction

1.1 Prevalence & incidence

The population prevalence of vitiligo ranges from 0.1% to 2% and shows a wide variability among ethnic groups (Bologna et al., 1998; Hann and Nordlund, 2000). Whereas the estimated population prevalence of vitiligo is approximately 0.38% for Caucasians in the United States and Northern Europe (Howitz et al., 1977), vitiligo affects 0.19% of the population in China (Xu et al., 2002). Other international studies show that the incidence of vitiligo ranges from 0.1 to over 8.8% (Srivastava, 1994; Schwartz and Janniger, 1997; Hann et al., 1997; Kovacs, 1998; Agarwal, 1998; Handa and Kaur, 1999; Alkhateeb et al., 2003). The highest incidence of the condition has been recorded in Indians from the Indian subcontinent, followed by Mexico and Japan (Table 1). The difference in its incidence may be due to higher reporting of vitiligo in a population, where an apparent color contrast and stigma attached to the condition may force patients to seek early consultation (Panja, 1947; Levai, 1958; Punshi and Thakre, 1969; Behl and Bhatia, 1971; Sehgal, 1974; Koranne and Sachdeva, 1988; El Mofty, 1968; Grunnet et al., 1970; Dawber, 1968; Perrot, 1973; Fornara, 1941; Canizares, 1960; Ruiz Maldonnado et al., 1977; Fitzpatrick, 1974; Arakawa, 1941; Khoo, 1962).

Vitiligo is reported more frequently in females than males, which may be the result of increased reporting rates in females due to greater social consequences in females affected by vitiligo (Kovacs, 1998; Lee Poole and Boissy, 1997; Hann and Lee, 1996; Zaima and Koga, 2002; Jeninger, 1993; Halder, 1997; Cho et al., 2000; Handa and Dogra, 2003).

Adults and children of both sexes are equally affected; however, the majority of the vitiligo cases are reported during stages of active development. About 50% of patients present before the age of 20 and nearly 70-80% present before 30 years of age. Although no age is immune to vitiligo, the disease is very rarely observed at birth (Behl et al., 2003; Jaigirdar et al., 2002; Engel, 2001; Lerner, 1999; Gauthier et al., 2003; Westerhof et al., 1996).

The proportion of patients with a positive family history varies from one part of the world to another, with particularly wide ranges reported in India (6.25-18%), with reports of up to 40% elsewhere in the world (Behl et al., 2003).

Author(s)	Year	City/ or Region/Country/Continent	Incidence (%)
El Mofty	1968	Egypt/ Africa	1
Panja	1947	Calcutta/India/ Asia	6
Levai	1958	Vellore/India/ Asia	4
Punshi & Thakre	1969	Amrawati/India/ Asia	8
Behl & Bhatia	1972	Delhi/India/ Asia	8.8
Sehgal	1974	Goa/India/ Asia	2.9
Koranne & Sachdeva	1988	Delhi/India/ Asia`	1.25
Howitz <i>et al.</i>	1977	Denmark/ Europe	0.38
Grunnet <i>et al.</i>	1970	Denmark/ Europe	1.44
Dawber	1968	England/ Europe	0.15
Perrot	1973	France/ Europe	3.0
Fornara	1941	Italy/ Europe	0.3
Canizares	1960	Mexico/ North America	4
Ruiz-Maldonado	1977	Mexico/ North America	2.6
Fitzpatrick	1974	Massachusetts/ United States/ North America	8
Arakawa	1941	Japan/ Asia	1.64
Khoo	1962	Malaysia/ Asia	0.7

Table 1. Vitiligo: Global Incidence Patterns

2. Epidemiology of vitiligo: A worldwide survey

Numerous studies have been conducted around the world concerning the epidemiological characteristics of vitiligo, in particular the racial, ethnic, and cultural differences in its prevalence.

2.1 Europe

2.1.1 Denmark

The prevalence of vitiligo was 0.38% in a representative population of 47,033 in Denmark. Both sexes were found to be equally affected, with no significant difference found in the distribution of vitiligo patients among five different municipalities or between urban and rural districts. New cases of vitiligo steadily increased with advancing age, its onset being most often between the ages of 40 and 60 years of age. The age-specific prevalence increased from 0.09% in patients under the age of 10 to 0.9% in the age group between 60 to 69 years. It was suggested that these characteristics of vitiligo in Denmark would also apply to northwest Europe (Howitz *et al.*, 1977).

2.1.2 United Kingdom

The characteristics of vitiligo in 41 adults presenting to a university dermatology clinic in Sheffield, United Kingdom were studied in a case review. Of 41 patients, there were 29 women (70.7%) and 12 men (29.3). The authors reported an age of onset before 20 years in 41.5% of patients (n=17), while the mean was 28 years. The oldest age of onset was 74 years. In these patients, the average duration of disease was 16 years. Autoimmune thyroid disease was present in 34.1% of cases (n=14). Only 17% (n=7) gave a family history of vitiligo (Mason and Gawck Rodger, 2005).

2.2 Middle East

2.2.1 Saudi Arabia: Qassim region

Alzolibani found that in a random sampling of vitiligo patients in the Qassim region of Saudi Arabia, approximately one-third of cases were positive for parental consanguinity.

A particularly high first-cousin consanguinity was noted in this study, which was found to be higher than that reported among the general Saudi population (22.5% vs. 19.5%) (Alzolibani, 2009; El-Hazmi et al., 1995).

Moreover, a positive family history was obtained in 56.8% of families studied, 57.1% of them having two or more affected relatives. The age of onset of vitiligo was 31 years in familial cases and 33 years in non-familial controls. Vitiligo occurred before the age of 20 in 19% of family cases and in 36% of non-familial controls. Most families (75%) had no more than two affected members.

As observed in this study, the incidence rate of vitiligo in relatives increased with a closer blood relationship to probands, which is indicative of the significant familial aggregation of vitiligo noted in a number of previous studies (Nath et al., 1994; Majumder et al., 1988). The proband cases in this study showed higher relative risks among their first- and second-degree relatives, but not as high among their third-degree relatives.

Inheritance pattern prediction using the frequency of vitiligo among siblings in relation to the general population coincided with the multifactorial model particularly for the vitiligo vulgaris subtype followed by the acrofacial subtype, and least in the focal subtype. Calculation of heritability showed a high weighted mean of 0.54.

Similar data from China supports these findings (Sun et al., 2006).

Genetic factors play a relatively important role in the evolution of vitiligo among subjects in the Qassim region. Recognition of this could have a potential impact on disease prevention through family counseling and other forms of intervention.

2.2.2 Kuwait

In a sample of 88 pediatric vitiligo patients at a hospital dermatology clinic, the age of onset was between 8 and 12 years in 51% of these patients (Al-Mutairi et al., 2005). A positive family history was obtained in 27.3% of the patients. Vitiligo vulgaris was the most common clinical type observed. Three patients, though clinically asymptomatic, incidentally had anti-thyroid antibodies, which are comparable to results published previously.

Eighty Korean children (ages 8 months-12 years) with clinical and/or histopathologic diagnoses of vitiligo were evaluated; 39 boys and 41 girls. The mean age at first visit was 7.9 years and the mean age at disease onset was 5.6 years. The children were compared with a control group of 422 adults with vitiligo. Children comprised 16% of the total vitiligo patients and adults comprised 84%. A family history of vitiligo was found in 11 (13.8%) of

children, compared to 10.7% in the adult group. ; pPoliosis was found in 20 (25%) of children. H; halo nevi was found in 2 (2.5%) of children, compared to 4% in the adult group; combined autoimmune and endocrine diseases were noted in 1 (1.3% of children), compared to 7.6% in the adult group; and segmental vitiligo in 26 (was diagnosed in 32.5% of children), compared to 13.0% in of the adult group. The Vitiligo and its associated conditions were combined diseases were significantly less often frequent found in children compared to than adults ($p < 0.01$), and segmental vitiligo was found in significantly higher numbers of children than the adult patients more often associated with children ($p < 0.0001$). This study does not show a higher prevalence of vitiligo in girls as reported in other studies, which may indicate a racial difference trait (Cho et al., 2000).

2.3 Indian subcontinent

2.3.1 India

In India, the incidence of vitiligo was reported to be between 1- 2 % (Majumder et al., 1988). In a large population-based study of vitiligo patients ($n=998$), 43% were male ($n=429$) and (57%) were females ($n=569$). The mean age at onset for males was found to be 23.3 years and for females was 17.4 years. The median age at onset in males was 18 years and 13.6 years in females. The earliest age at onset was found to be at birth and the oldest was 73 years (Tawade et al., 1997). Out of 998 cases, 272 (27.3%) had one or more relatives with vitiligo. Among these, 207 (76.1%) cases had only one relative affected whereas 65 (28%) cases had more than one relative with vitiligo.

The slightly higher prevalence in females may not be the true situation, as only self-reported cases were enlisted in the study. Due to the social stigma of vitiligo in the community, young females tend to report earlier due to matrimonial anxiety. The age at onset is consistent with previous studies (Mosher et al., 1987). Onset at birth is not so common. In the present study 3 cases had onset of vitiligo at birth, of which One infant's mother had vitiligo. The peak incidence between 5-14 years may reflect concerns about cosmetic disfigurement in this age group and parental anxiety leading to early reporting.

In another Indian study (Handa and Kaur, 1999), 1,436 patients were seen between 1989 and 1993. Males constituted 54.5% of the group and females, 45.5%. Mean age of the patients was 25 years, and average disease duration at the time of hospital visit was 3.7 years. Leukotrichia was present in 165 (11.5%), and Koebner's phenomenon was observed in 72 (5.0%). Twenty-nine (2%) patients had associated halo nevi. A family history of vitiligo was reported in 165 (11.5%) patients.

A study was performed in a military service hospital patient population utilizing 120 cases of vitiligo (Kar, 2001). The youngest patient in this series was a 2 year-old girl and oldest patient was 65 year old male. In 52 (43.2%) patients, disease started before the age of 20. The duration of disease varied from 2 months to ten years. Eight patients (6.6%) reported a family history of vitiligo. In one case, a mother and her two daughters had vitiligo. The male -to -female ratio in vitiligo was observed in this study to be nearly equal, meaning thereby this disease had no predilection for any gender. Similar observations were also noted by various researchers (Sarin and Kumar, 1977; Behl et al., 1961). Furthermore, the incidence of vitiligo was 43.2% in the age group of 20 years of age and younger, as compared to an incidence of 9.9% in individuals over 40 years of age. Universal vitiligo was found in 2 (1.6%) cases and both had a positive family history of disease. Other studies found a positive family history in 6.25-10% of cases (Sarin and

Kumar, 1977; Behl et al., 1961). The results of this study may indicate that the mode of vitiligo transmission may be caused by an autosomal dominant gene with variable penetrance (Ando et al., 1993; Behl et al., 1994).

In an Indian pediatric population (Handa and Dogra, 2003), 625 children with vitiligo were seen over 10 years: 357 (57.1%) were girls and 268 (42.9%) were boys. As compared to adult patients with vitiligo, this sex difference was found to be statistically significant ($p < 0.001$). The mean age of onset of the disease was 6.2 years. Leukotrichia was present in 77 patients (12.3%), while Koebner phenomenon was observed in 71 patients (11.3%). Halo nevi were observed in 29 patients (4.4%). Seventy-six patients (12.2%) had a family history of vitiligo.

A total of 365 patients were included in a study that focused on the clinical and sociodemographic aspects of vitiligo. There was a female preponderance of disease: females (68.4%) were found to be more affected than males (31.6%), in a ratio of 2.1:1 (Shah et al., 2008). The majority (32.82%) of the patients were in their second decade of life, and 58.63% of the patients were unmarried. A positive family history was present in 50 (13.7%) of patients, and first-degree relatives were affected in 35 of these patients. Vitiligo has a polygenic or autosomal dominant inheritance pattern with incomplete penetrance and variable expression (Bleehen et al., 1992; Moscher et al., 1993; Bologna and Pawelek, 1988). Familial occurrence has been reported to be in the range of 6.25% to 30% (Shajil et al., 2006). Positive family history is considered to be a poor prognostic factor for vitiligo.

The female-to-male ratio in this study was 2.1:1, which was different from other study findings (Handa and Kaur, 1999; Koranne et al., 1986). Most reports showed that males and females were affected with almost equal frequency, but females outnumbered males in this study presumably because of social stigma and the marital concerns which prompt women to seek early consultation. In 54.5% of the patients, the age at onset was in the first or second decade of life, consistent with most reports from India and the West.

2.3.2 Mumbai

In Mumbai, India, records of 33,252 new patients attending a dermatology outpatient department from June 2002 to June 2008 were analyzed for the presence of vitiligo (Poojary, 2011).

The total number of vitiligo patients was 204. The male: female proportion was almost equal. A family history of vitiligo was seen in 3.43% of cases. Associated autoimmune disorders were seen in 2.94% of cases and were mainly skin associated autoimmune diseases (morphea, alopecia areata, discoid lupus erythematosus, and pemphigus erythematosus), except for one case of Grave's disease. This may indicate that the association of vitiligo with other autoimmune diseases emphasizes the autoimmune etiology of vitiligo, and also the need to actively look for, and if necessary, investigate patients with vitiligo for other autoimmune diseases.

2.3.3 Calcutta

An epidemiological profile of vitiligo in Calcutta was gathered from 15,685 individuals drawn from the general population; pedigree data was collected from 293 vitiligo patients. The overall prevalence of vitiligo was about 5 per 1,000 individuals. There were no significant sex or age differences. About a 4.5-fold increase in prevalence was observed

among close biological relatives of affected individuals. There were no significant differences in the frequencies of various types of vitiligo between probands with and without positive family history. The overall mean and modal ages of onset were about 22 years and 15 years, respectively. The mean ages among males (24.8 years) and females (19.3 years) were significantly different (Das et al., 1985).

2.4 Africa

2.4.1 Tunisia

In a retrospective study of patients attending a Tunisian outpatient dermatological practice (Zeglaoui et al., 1985), 503 patients were reviewed from a 5-year period. There were 288 women (57.3%) and 215 (42.7%) men (F: M = 1.33). The average age was 28.2 years (3- 80 years). The peak of frequency was located in the second decade of the life (26%). A family history of vitiligo was found in 27% of cases. The average time of until initial consultation was 21 months. An association with other pathological conditions was found in 23% of cases which is consistent with available literature.

2.4.2 Nigeria

To investigate vitiligo in the Nigerian Africans, 351 patients with vitiligo, representing 3.2% of new dermatologic cases at a study wsite, were enrolled (Onunu and Kubeyinje, 2003). The study group was made up of 153 males (43.6%) and 198 females (56.4), giving a sex ratio of 1: 1.3. The peak incidence of vitiligo was in the second and third decades of life. There was a positive family history of vitiligo in 18% of subjects.

2.5 Caribbean

2.5.1 French West Indies: Isle of Martinique

A study was conducted in an academic dermatology clinic which analyzed a cohort of 2,077 dermatology outpatients. There was a vitiligo prevalence rate of 0.34%, with a predominance of affected females. The median age at onset was 29 years. Of the vitiligo patients, over 30% had a family history of vitiligo, 6% (n=2) had concurrent thyroid disease, 6% (n=2) had psoriasis, and 3% (n=1) had atopic dermatitis. These findings are comparable to data in Caucasian populations (Boisseau-Garsaud et al., 2000).

2.6 North America

2.6.1 United States

Data on 160 Caucasian families living in the United States was collected based on primary probands with vitiligo (Majumder et al., 1993). The rate at which first degree relatives were also afflicted with vitiligo is 20%. Children of probands were found to have 1.7 times the risk of vitiligo compared to other first-degree relatives. The relative risk (RR) for vitiligo was approximately 7 for parents, 12 for siblings, and 36 for children. For second-degree relatives, the RR varied between 1 and 16. The pattern of the relationship between RR and degree of kinship indicates the involvement of genetic factors, although it is not consistent with single-locus Mendelian transmission.

In general, patients with vitiligo who have an family history of vitiligo are more likely to have an earlier age of onset of disease than those with a negative family history (odds ratio = 3.70, P = .024). There was found to be no association between family history and site of onset, distribution, or course of disease. Onset of pediatric vitiligo also seemed to

be linked to a family history of vitiligo. This suggests that awareness of this association can allow for earlier detection and initiation of treatment (Pajvani et al., 2006).

3. Genetic heritability of vitiligo

3.1 Familial aggregation of vitiligo and relationship with autoimmune diseases

Familial aggregation of vitiligo was noted as early as 1933 (Majumder, 2000), suggesting that genetic factors might have an important effect on the development of vitiligo (Hafez et al., 1983). Although vitiligo aggregates in families, it does not appear to segregate in a simple Mendelian pattern (Majumder et al., 1993; Kim et al., 1997; Nordlund and Majumder, 1997). Previously, an autosomal recessive model of vitiligo that took the variability of the age of onset into account was proposed, suggesting that there might be genes at three or four autosomal loci controlling vitiligo (Alkhateeb et al., 2002; Majumder et al., 1988). This was supported by the high frequency of vitiligo and other autoimmune diseases in isolated inbred communities. On the other hand, the actual onset of vitiligo in genetically susceptible individuals seems to require exposure to environmental triggers (Nath et al., 1994; Birela et al., 2008). Attempts to identify genes involved in vitiligo susceptibility have involved gene expression studies, allelic association studies of candidate genes, and genome-wide linkage analyses to discover new genes (Zhang et al., 2008).

Most evidence indicates that generalized vitiligo is an organ-specific autoimmune disease directed against melanocytes (Ongenae et al., 2003; Rezaei et al., 2007), and indeed about 20% of vitiligo patients (and their close relatives) manifest concomitant occurrence of other autoimmune diseases, particularly autoimmune thyroid disease, rheumatoid arthritis, late-onset type I diabetes mellitus, psoriasis, pernicious anemia, systemic lupus erythematosus, and Addison's disease (Alkhateeb et al., 2003). Nevertheless, heritable biological properties of the melanocyte or other factors, combined with environmental triggers, may contribute to loss of immune tolerance and ultimately autoimmunity directed against melanocytes (Boissy and Spritz, 2009). Family clusters of vitiligo cases are not uncommon, occurring in a non-Mendelian pattern suggestive of polygenic, multifactorial inheritance. Probands' first-degree relatives have 6-7% risk of developing generalized vitiligo, and the concordance rate in monozygotic twins is 23%.

Genetic linkage and association studies have implicated a number of genes in vitiligo pathogenesis, especially genes involved in immune function (Spritz, 2007; Spritz, 2008). However, these loci account for a relatively small fraction of total disease liability. Genetically isolated "founder populations" afford special opportunities to identify genes involved in susceptibility to disease, as founder populations may have elevated prevalence of specific diseases and reduced heterogeneity of causal genetic and environmental risk factors compared with more outbred populations (Wright et al., 1999). Accordingly, susceptibility alleles that represent relatively minor genetic risk factors for complex diseases in the general population may become amplified and constitute major risk alleles in a founder population, and thus may be localized using less dense maps and smaller sample sizes than similar studies conducted in more outbred populations (Wittke-Thompson et al., 2007).

3.2 Genetic basis of vitiligo

Genes play a role in all aspects of vitiligo pathogenesis, even in response to environmental triggers. Typical generalized vitiligo behaves as a "complex trait", meaning it is a polygenic, multifactorial disease involving multiple genes and non-genetic factors. Only a few vitiligo

susceptibility genes have been identified with reasonable certainty. These include human leukocyte antigen (HLA), protein tyrosine phosphatase, non-receptor type 22 (*PTPN22*), and, *NACHT, LRR and PYD domains-containing protein 1 (NALP1)*, all genes associated with autoimmune susceptibility. Cytotoxic lymphocyte antigen 4 (*CTLA4*) is also under investigation (Spitz, 2008).

The earliest evidence suggesting a genetic basis for vitiligo was its association with a number of other autoimmune disorders known to have heritable predispositions, such as type 1 diabetes mellitus. Furthermore, genetic diseases are substantially more prevalent in children of parents who are close relatives. In an Indian study of a community with a predominance of consanguineous marriages, 20% of individuals had vitiligo (Ramaiah et al., 1988). Significantly earlier onset has been observed when there is a family history of vitiligo (24.8 vs. 42.2 years of age) (Hann and Lee, 1996).

Genetic models suggested by analysis of family studies include a multifactorial model (Goudie et al., 1983), a dominant model with incomplete penetration (Hafez et al., 1983), and a multilocus recessive model (Majumder et al., 1988). There may also be two coexisting modes of inheritance for vitiligo depending on age of onset (Arcos-Burgos et al., 2002). In patients with early onset vitiligo (before the age of 30), vitiligo inheritance most closely follows a dominant mode of inheritance with incomplete penetration. However, a predisposition for vitiligo resulting from a recessive genotype and exposure to certain environmental triggers appears to explain the inheritance pattern of late onset vitiligo (after 30 years of age). Specific HLA haplotypes are strongly associated with family history of vitiligo, severity of disease, age of onset, and population geography (Zamani et al., 2001; Ando et al., 1993; Finco et al., 1991). Gene polymorphisms in the major histocompatibility complex (MHC) Class II region of the HLA locus have been previously found to be associated with other autoimmune diseases, such as type 1 diabetes mellitus and juvenile-onset rheumatoid arthritis (Deng et al., 1995; Prahalad et al., 2001). The HLA genes encoding both the transporter associated with antigen-processing (*TAP1*) and subunits of the immunoproteasome latent membrane protein 2 and 7 (*LMP2/LMP7*) have been found to be associated with vitiligo of early onset in Caucasian patients (Casp et al., 2003).

The (*CTLA-4*) gene encodes a protein involved in the inhibition of improperly-activated T-cells. *CTLA-4* variants have been linked to numerous autoimmune diseases. There is an association between the *CTLA-4* polymorphism and the occurrence of vitiligo with other autoimmune comorbidities (Blomhoff et al., 2005). Catechol-O-methyl transferase (*CTLA-4*) is an enzyme that plays a major role in the metabolism of toxic or biologically active drugs, neurotransmitters and metabolites. One such metabolite, O-quinones, can be formed during melanin synthesis in the absence of adequate *CTLA-4* activity. A *CTLA-4* polymorphism has been found to be significantly associated with acrofacial vitiligo (Tursen et al., 2002).

Chromosome 1p31, termed the autoimmune susceptibility locus (*AIS1*), has been found to be associated to a highly significant degree with generalized vitiligo in Caucasians living in North America and the United Kingdom (Fain et al., 2003). Reduced activity of the *VIT1* gene, located on chromosome 2p16, has been associated with increased susceptibility to vitiligo, possibly as a result of dysfunction of melanocyte nucleotide mismatch repair (Lee Poole, 2001).

A genome-wide association study of generalized vitiligo in an isolated European founder population identified a significant association of single-nucleotide polymorphisms in a block on band 6q27, in close vicinity to *IDDM8*, which is a linkage and an association signal for type I diabetes mellitus and rheumatoid arthritis. Only one gene, *SMOC2*, is in the region of

association, within which single-nucleotide polymorphism (SNP) rs13208776 attained genome-wide significance for association with other autoimmune diseases and vitiligo (Birlea et al., 2009).

Genetic risk for vitiligo is well-supported by multiple lines of evidence. Vitiligo is frequently associated with familial clustering (Alkhateeb et al., 2003; Goudie et al., 1983; Mehta et al., 1973; Carnevale et al., 1980). Approximately 20% of probands have at least one affected first degree relative. The risk of first degree relatives of patients with vitiligo for developing the disease is elevated by 7- to 10-fold compared to the general population (Alkhateeb et al., 2003; Sun et al. 2006).

In addition, segregation analysis suggests that vitiligo is a multifactorial and polygenic disorder that likely results from multiple genetic and environmental factors (Alkhateeb et al., 2003; Arcos-Burgos et al., 2002; Nath et al., 2001; Spritz et al., 2004). However, no disease genes have been identified for vitiligo thus far. Several genome-wide linkage analyses of vitiligo have been performed in the past few years, and multiple linkages to vitiligo have been identified (Alkhateeb et al., 2002; Fain et al., 2003; Spritz et al., 2004). Co-segregation of systemic lupus erythematosus and vitiligo in European American pedigrees revealed significant linkage on 17p13 (Nath et al., 2001). Another co-segregation of vitiligo and Hashimoto thyroiditis identified a candidate gene with highly significant linkage at a locus ("AIS1") on chromosome 1p32.2-p31.3 (Alkhateeb et al., 2002; Spritz et al., 2004), as well as additional linkage evidence on chromosomes 1, 7, 8, 11, 19, and 22 (Spritz et al., 2004). There are confirmed linkage findings on chromosomes 7q and 8p (AIS2 and AIS3) (Nath et al., 2001). The linkage evidence at the AIS1, AIS2, and systemic lupus erythematosus, vitiligo-related 1 (SLEV1) loci was mainly from autoimmunity-associated families, while the evidence at the AIS3 locus was primarily from non-autoimmunity-associated families, suggesting that generalized vitiligo may be divided into two distinct phenotypic subcategories that involve different disease loci or alleles.

4. Conclusion

Vitiligo is a common, acquired, discoloration of the skin. Most studies show that vitiligo is common in the younger age group, with females of reproductive age forming the major group. Genetic factors play a relatively important role in the evolution of vitiligo. The extent of familial aggregation of vitiligo is statistically significant. The genetic model of vitiligo may be consistent with a polygenetic or multifactorial inheritance in a dominant gene pattern.

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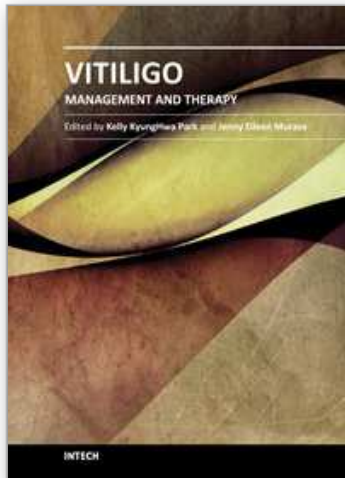
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