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Climate might be considered as a risk factor for anorexia nervosa? A hypothesis worth another look

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ABSTRACT

Environmental factors, such as ambient temperature m(AT), may have a causal role in the development of anorexia nervosa (AN), in addition to factors like the idealization of thinness. We present the literature and a bibliographic analysis that associate AN and a temperate climate.

1. Introduction

The first reference linking AN to AT was an editorial in the *Lancet*, on 24 March 1888, which stated, 'Most of the cases seem to occur in the colder months of the year, and possibly this may be more than a coincidence' (Anonymous, 1888, p. 584). This observation of the effect of cold weather on the expression of AN appeared as an editorial comment by W. Gull to cases he had reported the preceding week in the *Lancet*.

By what mechanism could AT effect AN? In a cold environment, reduced body insulation due to weight loss could endanger thermoregulatory homeostasis, which in turn could trigger an increase in physical activity to produce heat as a remedy for the hypothermia (Gutiérrez, Vázquez, & Boakes, 2002). As noted by Arthur Crisp (2002), "Fat has general biological purposes as a reserve of energy and a contributor to body temperature regulation, both as a component of resting metabolic rate and, subcutaneously as insulation" (p. 481).

Warm environments are also known to inhibit and reverse self-starvation in an animal model analogous to AN (Gutierrez, 2013). AT has a marked effect on the running activity of animals exposed to a restrictive feeding schedule (Cerrato, Carrera, Vazquez, Echevarría, & Gutierrez, 2012; Gutierrez, Baysari, Carrera, Whitford, & Boakes, 2006; Gutierrez, Cerrato, Carrera, & Vazquez, 2008; Gutierrez et al., 2009; Hillebrand, de Rijke, Brakkee, Kas, & Adan, 2005).

Hyperactivity has been reported in up to 80% of patients with AN (Davis et al., 1997). A sharp increase in activity is observed in female adolescents approximately 1 year before the diagnosis of AN (Davis, Blackmore, Katzman, & Fox, 2005). Both of these observations suggest increased physical activity could precipitate the development of AN by strengthening the positive feedback loop between diet and activity.

In a recent study (Carrera et al., 2012), higher physical activity was present in adolescent AN patients during cold months. This association was shown to be independent of other climatic aspects associated to AT, like length of day or seasonality. A subsample of patients who experienced an AT difference greater than 4 °C between two consecutive 3-day periods of activity was analyzed. Their physical activity was significantly greater at the lower temperature.

The pattern of body weight fluctuation during the year is different in AN restrictive subtype patients (ANR) than AN binge/purging subtype patients (ANP) (Gutierrez et al., 2012). A retrospective study of admissions to an adolescent inpatient eating disorders unit in Madrid (Spain) over a 4-year period revealed differences in BMI between ANP and ANR patients during the colder months of the year. The weight of ANP patients is higher during the coldest months of the year and lower in the warmest, similarly to the annual fluctuation in bodyweight in the general population (Attarzadeh, 1983; Dzien & Dzien-Bischinger,

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2003). The pattern for ANR patients is the opposite, i.e., lower BMI in the colder months of the year. As well, the length of hospital stay was significantly longer for ANR patients during the cold time of year.

The recovery of menses in AN is related to AT. AN patients are more likely to recover menses during the warmer months of the year (Favaro & Santonastaso, 2009). During the spring and summer months, patients with AN recover menses without hormone therapy, even though they weigh less (average of 2 kg less) compared to weight recorded in the winter months.

Does an elevated AT reduce the incidence of AN? Most epidemiological studies have been conducted on populations in temperate climates between 40° and 65° latitude in the northern hemisphere other than those by Hoek who has reported few cases of AN in Curacao (Hoek & van Hoeken, 2003; Hoek et al., 1998; 2005).

2. Methods

We proposed to study the incidence and prevalence of AN indirectly by using a bibliometric technique (Vazquez, Carrera, Birmingham, & Gutierrez, 2006). We compared the number of references in the literature to AN at different latitudes by mapping them, according to the institutional affiliation of their first author. We used the latitude because it is closely related to AT and the main factor that determines a region's climate. However, within given latitude, the altitude, the proximity to the coastline and the influence of the oceanic stream are also key factors. We hypothesized that the number of reports of a disease at any latitude would be proportional to the incidence and prevalence of that disorder.

To test our hypothesis and provide comparison, we employed the same method on a variety of diseases: (a) some believed in the medical literature to have an incidence and prevalence that changes with latitude (psoriasis (PSOR), cataracts (CAT) and seasonal affective disorder (SAD)) and (b) some believed not to be effected by latitude (schizophrenia (SCHIZ) and anxiety disorders (ANX)).

The details of the analysis are presented in the methods section of Vazquez et al. (2006). The analysis was performed for 1990 until 1999. References for PSOR and CAT were retrieved from Medline, a database specialized in medical literature, while references for the mental disorders; AN, ANX, SCHIZ and SAD were retrieved from PsycLit. Nonparametric statistical analysis was performed using chi-square analysis, and due to the large number of references for some disorders, only analysis yielding significant differences beyond $p = 0.001$ level was reported.

3. Results

More than 95% of references for the six disorders were from the northern hemisphere, where approximately 88% of the world's population lives (Rankin, 2008). Fig. 1 shows the percent of references for the six disorders at different latitudes in the NH. New analysis not performed in Vazquez et al. (2006) shows that there were few references at both extremes of the latitude continuum (2.9% in the tropical region from Ecuador to the Tropic of Cancer, 0°–24°, and 7.6% in the northern latitude range 55°–64°).

References to CAT are significantly higher at the lower, 0°–24° latitude, $\chi 2(1, N = 12920) = 108.1$, $p < 0.0001$, whereas PSO is significantly higher than CAT at the higher 55°–64° latitude, $\chi 2(1, N = 12920) = 97.3$, $p < 0.0001$. SAD was associated with higher latitudes and did not differ from PSO ($\chi 2$ (1, $N = 4501$) = 1.94, $p = 0.16$, ns) at the higher latitude range shown in Fig. 1, but it significantly differed from CAT ($\chi 2$ (1, $N = 9124$) = 31.2, $p < 0.0001$).

Three quarters of all NH references were from latitudes between 35° and 54°. However, references for AN and PSO in the latitude range 35°–44° were significantly lower than references for ANX and SCHIZ [AN < ANX, $\chi 2$ (1, $N = 3693$) = 4.8, $p = 0.03$; AN < SCHIZ, $\chi 2$ (1, $N = 11887$) = 7.68, $p = 0.006$; PSO < ANX, $\chi 2$ (1, $N = 6615$) = 7.6, $p = 0.006$; PSO < SCHIZ, $\chi 2$ (1, $N = 14809$) = 17.9, $p < 0.0001$)], while in the latitude range of 45°–54°, the percentage of references to PSO and AN were significantly higher than those for the other disorders ANX and SCHIZ [AN > ANX, $\chi 2$ (1, $N = 3693$) = 73.4, $p < 0.0001$; AN > SCHIZ, $\chi 2$ (1, $N = 11887$) = 81.9, $p < 0.0001$; PSO > ANX, $\chi 2$ (1, $N = 6615$) = 87.7, $p < 0.0001$; PSO > SCHIZ, $\chi 2$ (1, $N = 14809$) = 134.4, $p < 0.0001$).

The distribution of AN references in the NH only differs significantly from PSO percentages at the higher 54°–64° latitude range shown on Fig. 1 [AN < PSO, $\chi 2$ (1, $N = 5376$) = 29.8, $p < 0.0001$)], but there were no differences at other latitude ranges. The two disorders are associated with high latitudes in the NH, half of references to AN in the NH were from latitudes greater than 45° [SAD, 47%, $\chi 2$ (1, $N = 1579$) = *1.46*, $p = 0.22$, ns] and PSOR, 52%, $\chi 2$ (1, $N = 5376$) = 0.91, $p = 0.33$, ns], but AN references over latitude 45° were significantly greater than those obtained by SCHIZ [39%, $\chi 2$ (1, $N = 11887$) = 60.89, $p < 0.0001$] and ANX [35%, $\chi 2$ (1, $N = 3963$) = 82.27, $p < 0.0001$].

4. Discussion

CAT was associated with low latitudes. SAD and PSO were associated with high latitudes. AN had a similar geographical distribution to

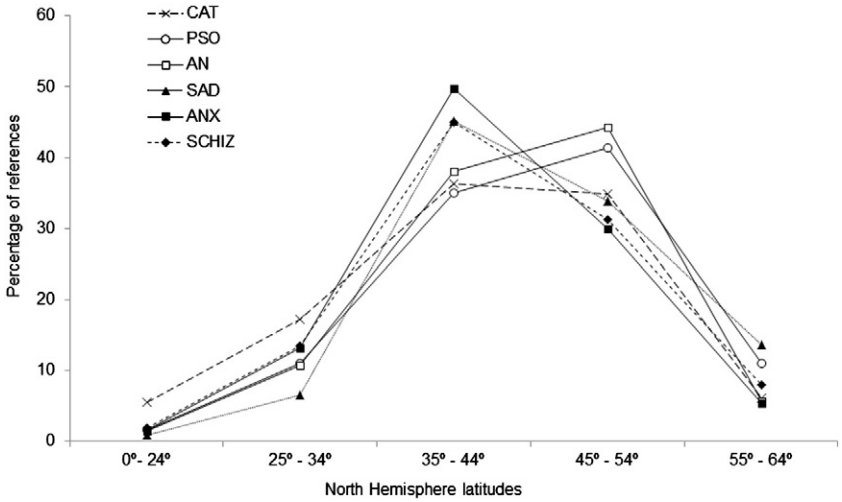

Fig. 1. Distribution of references to six disorders in Northern Hemisphere for the period 1990–1999. CAT, cataracts; PSO, psoriasis; AN, anorexia nervosa; ANX, anxiety disorders; SCHIZ, schizophrenia.

PSO, which is known to be associated with reduced sunlight at higher latitudes. The latitude range from which most of the references to AN were authored closely corresponds to the warm temperate climates zones (groups C and D in the Köppen–Geiger climate classification (http://koeppen-geiger.vu-wien.ac.at/present.htm; Kottek, Griesser, Beck, Rudolf, & Rubel, 2006). In particular, maritime and continental temperate climates classified with the Cfb, Dfa and Dfb nomenclature (where the second letter indicates the precipitation pattern and the third letter indicates the degree of summer heat) were located in the North Hemisphere between the latitudes of 45° and 55. The epidemiological data available from non-temperate latitudes under 40°N and the bibliometric findings are consistent with a protective role of warmer environments.

5. Conclusion

Our bibliometric analysis shows an association between AT and AN. This does not prove a causal association. There may be confounders that are responsible for this result such as reduction in anxiety and change in neurotransmitters. On the other hand, clothing, air conditioning and housing could reduce the size of the effect. The importance of this result relates to the other research relating to warming, temperature, body weight exercise and animal research. Nevertheless, the influence of AT remains largely unaccepted and infrequently used in treatment (Bergh, Brodin, Lindberg, & Sodersten, 2002; Birmingham, Gutierrez, Jonat, & Beumont, 2004; Court, Bergh, & Södersten, 2008; Gutierrez & Vazquez, 2001; van Elburg et al., 2012). However, if true, treating a patient by changing AT would be easy and inexpensive.

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Contributors

All authors contributed equally to the manuscript.

Conflict of interest

We declare that we have no conflict of interest.

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