Available online at www.sciencedirect.com
SCIENCE DIRECT®
Int. J. Hyg. Environ.-Health 208 (2005) 341–356
International Journal of Hygiene and Environmental Health
www.elsevier.de/ijheh

Is lead considered as a risk factor for high blood pressure during menopause period among Saudi women?

Iman Al-Saleh[a,*], Neptune Shinwari[a], Abdulla Mashhour[a], Gamal El-Din Mohamed[b], Mohammad Abu Ghosh[c], Zaki Shammasi[c], Abdulaziz Al-Nasser[c]

[a]*Biological and Medical Research Department, King Faisal Specialist Hospital and Research Centre, P.O. Box 3354, Riyadh 11211, Saudi Arabia*
[b]*Biostatistics, Epidemiology and Scientific Computing Department, King Faisal Specialist Hospital and Research Centre, Riyadh, Saudi Arabia*
[c]*Department of Family Medicine and Polyclinics, King Faisal Specialist Hospital and Research Centre, Riyadh, Saudi Arabia*

Received 30 December 2004; received in revised form 16 April 2005; accepted 17 April 2005

Abstract

This case–control study was designed to examine the association between blood lead levels and high blood pressure in a restricted subpopulation, Saudi women who were 45–93-year old, during or after menopausal period and not occupationally exposed to lead. Blood lead levels were assessed in 100 women with hypertension and 85 control subjects. Lead concentrations were measured in the whole blood using flameless atomic absorption spectrophotometry. Blood pressure measurements were performed according to the World Health Organization recommendations. Results revealed that the mean blood lead levels for hypertensive were 47.52 ± 39.26 and 45.59 ± 28.55 μg/l for controls. Participants were classified according to the median of blood lead levels in order to compute odds ratios. After controlling a number of potential confounding variables, the multiple logistic regression analysis revealed that women with blood lead levels of $\geqslant 38.6$ μg/l were 5.27 times more likely to be hypertensive than those with blood lead levels of < 38.6 μg/l, but of borderline significance ($p = 0.06$). Although such observation might support the hypothesis that the depletion of lead from bones during menopause increases blood lead levels placing women at increased risk for high blood pressure, there is a need for further studies with larger number of subjects.

A number of risk factors, which were suspected to influence blood lead levels, were also investigated. Use of Kohl, duration of its use, osteoporosis disease and intake of calcium supplements were significantly associated with blood lead levels.

Keywords: Blood lead levels; Hypertension; Menopause; Saudi Arabia

Introduction

Lead is a toxic agent with no known physiological function in the human body. There is concern about a possible effect of lead on blood pressure. Excessive

*Corresponding author. Tel.: +966 1 442 4772; fax: +966 1 442 7858.
E-mail address: iman@kfshrc.edu.sa (I. Al-Saleh).

1438-4639/$ - see front matter © 2005 Elsevier GmbH. All rights reserved.
doi:10.1016/j.ijheh.2005.04.004

exposure to lead is associated with impairment of the kidney and multiple organ systems. There is a rising public health interest in possible effects of environmental lead exposure on the cardiovascular system, and in the role of chronic low-level lead exposures in the pathogenesis of hypertension, a leading risk factor for cardiovascular disease morbidity and mortality (Hertz-Picciotto and Croft, 1993). Experimental animal studies in several species have reported that lead intake is associated with a moderate elevation of blood pressure (Piccinini et al., 1977; Revis et al., 1981; Boscolo and Carmignani, 1988; Fouts and Page, 1942; Bogden et al., 1991). These studies have implicated disturbances in calcium metabolism, particularly its role in modulating blood pressure through control of vascular tone, as the likely mechanism of action. The mechanism is universal in mammals, including man. Lead has been postulated as causing hypertension by inducing an alpha adrenoceptor-mediated vasoconstriction (Bertel et al., 1978). Increased renin and angiotensin production, due to the nephrotoxicity of lead, could also be factors in causing elevated blood pressures (Jhaveri et al., 1979). The association between blood lead level and elevated blood pressure is still subject to controversy. Several studies on the general population have been carried out. Some have argued that there is a positive association (Schwartz, 1995; Harlan et al., 1985; Beevers et al., 1976; Neri et al., 1988; Bener et al., 2001), while others have not (Pocock et al., 1984; Elwood et al., 1988; Grandjean et al., 1989; Den Hond et al., 2002). Different patterns of environmental exposure and racial differences might contribute to discrepancies in the findings of different studies (Vupputuri et al., 2003; Rothenberg et al., 1999).

According to the National Academy of Sciences panel (National Research Council, 1993), the effects of lead on blood pressure in adults may occur at extremely low levels (6 and 7 μg/dl). Others have argued that the relationship between lead levels and blood pressure is less well established than that for childhood cognitive deficits (Pirkle et al., 1985; Needleman et al., 1990; Landrigan, 1989).

More than 90% of lead is stored in the bone, while the remainder is found in the blood and soft tissues (Schroeder and Tipton, 1968; Wittmers et al., 1988). Bone stores of lead are not inert, however, and may become bioavailable when the bone is demineralized. Lead competes with calcium for transport and for binding sites and is released, along with calcium, when bone is resorbed (Rosen and Wexler, 1977; Pounds, 1984; Pounds and Rosen, 1986; Bronner, 1992; O'Flaherty, 1992; Simons, 1993). Although the rate of bone uptake is more rapid for calcium than for lead, the mechanisms by which these elements enter and leave the bone are similar. These include rapid exchange at all bone surfaces in close contact with the blood, slow exchange by diffusion through the crystalline matrix, incorporation into mineralizing bone, and release to the blood with resorbing bone (O'Flaherty, 1992; Marcus, 1985). Through these mechanisms, bone lead equilibrates with blood lead. The rate of accumulation of lead within the skeleton is not uniform, but is a function of age, bone type (i.e. cortical or trabecular bone) and skeletal site (Wittmers et al., 1988; Aufderheide and Wittmers, 1992). Since lead has a very long half-life in the bone (Piccinini et al., 1977; Revis et al., 1981; Boscolo and Carmignani, 1988; Fouts and Page, 1942; Hryhorczuk et al., 1985), levels accumulate progressively with age until middle (Schroeder and Tipton, 1968) or late life when some decline occurs (Wittmers et al., 1988).

Bone resorption is accelerated during certain physiologic processes (e.g. pregnancy and lactation), can manifest itself in clinical disease, such as osteoporosis, and is an inevitable consequence of aging (Riggs and Melton, 1986; Cummings et al., 1985; Gallagher, 1990; Symanski and Hertz-Picciotto, 1995). Postmenopausal osteoporosis is a major bone disease associated with increased risks of bone deformation and fractures that are of particular concern in the elderly population (Riggs and Melton, 1986; Cummings et al., 1985) The extent of mineral depletion from bone in osteoporotic women has been estimated to range from 2% to 10% and occurs usually over the first 2–4 years following cessation of menses (Ruegsegger et al., 1984). The mechanisms of postmenopausal osteoporosis are not well understood, and changes in estrogen levels, parathyroid hormone (PTH) release, decreased hormone receptor sensitivity, changes in bone cellular physiology, impaired vitamin D activation, and reduced intestinal absorption of dietary calcium have all been proposed as mechanisms (Nordin et al., 1976; Richelson et al., 1984; Johnston et al., 1985; Silbergeld et al., 1988). Estrogen deficiency may be largely responsible for the increase in bone resorption among postmenopausal women, and many studies have reported more rapid bone loss in women with surgically induced menopause, apparently because the withdrawal of estrogen is immediate rather than gradual (Stepan et al., 1987; Bagur and Mautalen, 1992; Biberoglu et al., 1993). Because bone loss may result in the release of lead stored in bone, menopause and postmenopausal women may experience increased blood lead levels. Significant differences were observed in the blood lead levels between postmenopausal and premenopausal women (Silbergeld et al., 1988; Grandjean et al., 1992). Postmenopasual women who had never been pregnant were found to have higher lead levels than did postmenopausal women who had been pregnant (Silbergeld et al., 1988). The suggested explanation was that the alteration of calcium metabolism during pregnancy and lactation results in the depletion of lead stored in bone, leaving the gravid women with fewer stores to be mobilized at menopause (Pitkin et al., 1979).