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Research Article

Association between Hematopoietic Function and Physical Activity in Caregivers

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Abstract

Background: Caregiver sense of physical and mental burden differs depending on their health and psychological state. Given that they may be in poor health due to long hours of caregiving and nighttime care, they are expected to be under undue stress. Although anemia may influence the sense of fatigue among elderly caregivers, no study has assessed the relationship between their hematopoietic state and amount of physical activity. The present study aimed to assess the relationship between anemia-related parameters that reflect hematopoietic function and amount of physical activity in caregivers.

Methods: This cross-sectional study evaluated the relationship between anemia-related parameters that reflect hematopoietic function, including red blood cell count (RBC), hemoglobin level (Hb), hematocrit (HT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC), and physical activity using linear regression.

Results: An association was observed between anemia-related parameters and physical activity. The model with age, sex, and physical activity (housework score, sports score, leisure score, total score) as independent variables showed an R^2 of 23.4% ($p<0.05$) for RBC, 40.5% ($p<0.01$) for Hb, and 35.9% ($p<0.01$) for Ht. Housework was an independent factor associated with RBC, Hb, and Ht, and total physical activity was an independent factor associated with Hb.

Discussion: None of the participants exhibited severe anemia, but likely had maintained a relatively high level of physical activity, which may have allowed them to balance housework with caregiving. Caregiving activities are not rigorous, and thus less likely to increase intramuscular iron demand and cause iron loss through sweating.

Conclusion: Our findings suggest the need for caregivers to maintain their nutritional status through adequate dietary management, prevent infections and the onset or exacerbation of chronic diseases, manage health over time, and maintain hematopoietic function.

Keywords: caregiver, hematopoietic function, anemia, physical activity

Introduction

Caregivers may be in poor health due to long hours of care [1], including nighttime care [2]. The health [3] and psychological status [4] of caregivers vary and can be accompanied by problematic behaviors. This results in different physical [5] and psychological burdens [6] among caregivers, a major social problem. In many cases, caregivers experience undue stress due to the lack of family members to talk to or help them with caregiving, leaving them to care for loved ones on their own. This stress can lead to chronic fatigue [7],

depression [8], and sleep deprivation [9] [10], among other problems. Even when their physical health is impaired, caregivers must continue to provide care. In many cases, caregivers have a strong sense of responsibility and are unable to delegate care to others or rely on others to provide care. They tend to work extremely hard, are easily fatigued, and take on caregiving tasks alone, which contributes to the accumulation of stress.

Anemia, even if mild, can affect the physical abilities and quality of life of older adults [11]. Most studies of caregivers tend to focus on the psychological effects of caregiving, and only a few have touched on physical aspects. Anemia may be a factor that influences fatigue in elderly caregivers. However, no study has assessed the relationship between their hematopoietic state and physical activity levels. To this end, the present study aimed to assess the relationship between anemia-related parameters and physical activity in caregivers.

Methods

Participants

Participants of this study were healthy caregivers aged ≥65 years living with a patient with senile dementia of the Alzheimer's type. Those who were under regular treatment at a medical facility and had a poorly controlled chronic disease were excluded.

Research Design

This cross-sectional study assessed the relationship between anemia-related parameters and physical activity in caregivers.

Assessments

Anemia-related parameters were used to assess the hematopoietic function of caregivers and included red blood cell count (RBC), hemoglobin level (Hb), hematocrit (HT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC).

RBCs transport oxygen to cells, receiving oxygen dioxide and carrying it to the lungs. Hb is found in red blood cells and is responsible for transporting oxygen. When Hb levels drop, anemia symptoms appear. Ht is the percentage of red blood cells in the blood; RBC, Hb, and Ht can be used to test for anemia and hypercythemia; and MCV, MCH, and MCHC can be used to determine the cause and type of anemia.

A daily living activity survey was conducted to measure total physical activity. Total physical activity score (TS) was calculated as the sum of the housework score (HS), sports score (SS), and leisure score (LS)[12]. $P<0.05$ was considered statistically significant.

Ethical Considerations

This study was approved by the Bioethics Review Committee of Nagoya University. Written informed consent was obtained from all subjects.

Results

Participants were caregivers aged ≥65 years who care for patients with dementia. There were more female than male caregivers. Table 1 summarizes the anemia-related parameters of caregivers, with RBC, Hb, Ht, MCV, MCH, and MCHC all falling within reference ranges. Table 2 shows correlations between anemia-related parameters. RBC was correlated with Hb ($r=0.834$, $p=0.000$), Ht ($r=0.885$, $p=0.000$), MCV ($r=-0.524$, $p=0.000$), and MCH ($r=-0.368$, $p=0.007$); Hb was correlated with RBC and Ht ($r=0.969$, $p=0.000$) and MCHC ($r=0.513$, $p=0.000$); Ht was correlated with RBC, Hb, and MCHC ($r=0.286$, $p=0.040$); MCV was correlated with RBC and MCH ($r=0.907$, $p=0.000$); MCH was correlated with RBC, MCV, and MCHC ($r=0.574$, $p=0.000$); and MCHC was correlated with Hb, Ht, and MCH.

Table 3 shows correlations between anemia-related parameters and physical activity. Anemia-related parameters were not correlated with HS, SS, LS, or TS. Table 4 shows associations between anemia-related parameters and physical activity by linear regression analysis using a statistically significant Hb model with age, sex, HS, SS, LS, and TS as independent variables. The results showed significant associations with physical activity for RBC, Hb, and Ht, but not for MCV, MCH, and MCHC.

Table 5 shows associations between anemia-related parameters and physical activity by linear regression analysis. The model with age, sex, HS, SS, LS, and TS as

independent variables had an R^2 of 23.4% ($p<0.05$) for RBC, 40.5% ($p<0.01$) for Hb, and 35.9% ($p<0.01$) for Ht. HS and gender were independent factors associated with RBC, Hb, and Ht. TS was an independent factor associated with Hb. Age was an independent factor associated with Hb and Ht. SS score was not associated with any of the anemia-related parameters. In MCV, MCH, and MCHC models with gender, age, HS, SS, LS, and TS as independent variables, no significant associations were observed.

Table1. Participant characteristics

	Mean	SD
RBC	431.85	46.39
Hb	13.46	1.36
Ht	41.32	3.74
MCV	95.95	4.81
MCH	31.23	1.88
MCHC	32.55	0.84

Reference values: Red blood cell count (RBC), M: 427-570, F: 376-500 (×10⁴/μL);

Hemoglobin level (Hb), M: 13.5-17.6, F: 11.3-15.2 (g/dL); Hematocrit (HT), M: 39.8-51.8, F: 33.4-44.9 (%); MCV, 85-102 (M: 82.7-101.6, F: 79.0-100.0) (fL); MCH, 28.0-34.0(M: 28.0-34.6, F: 26.3-34.3) (pg); and MCHC, 30.2-35.1(M: 31.6-36.6, F: 30.7-36.6) (%)

Table2. Correlations between anemia-related parameters

		RBC	Hb	Ht	MCV	MCH	MCHC
RBC	r	1					
	p						
Hb	r	.834	1				
	p	.000**					
Ht	r	.885	.969	1			
	p	.000**	.000**				
MCV	r	-.524	-.019	-.071	1		
	p	.000**	.893	.616			
MCH	r	-.368	.204	.063	.907	1	
	p	.007**	.147	.656	.000**		
MCHC	r	.157	.513	.286	.177	.574	1
	p	.265	.000**	.040**	.210	.000**	

*Pearson's correlation coefficient,*p<0.05, **p<0.01.*

Table3. Correlations between anemia-related parameters and physical activity

		RBC	Hb	Ht	MCV	MCH	MCHC
HS	r	.188	.134	.143	-.177	-.121	.048
	p	.182	.343	.314	.208	.393	.736
SS	r	-.061	-.049	-.028	.123	.065	-.093
	p	.667	.731	.846	.387	.645	.514
LS	r	-.106	-.193	-.163	-.081	-.153	-.194
	p	.454	.170	.247	.569	.278	.169
TS	r	.078	.052	.073	-.026	-.031	-.036
	p	.582	.716	.608	.852	.825	.798

Pearson's correlation coefficients

Housework Score: HS, Sports Score: SS, Leisure Score: LS, Total Score: TS

Table4. Associations between anemia-related parameters and physical activity by linear regression analysis

Dependent variable	R^2	Adjusted R^2	Standard error of the estimate	F value	p
RBC	0.234	0.150	42.758	2.805	.027*
Hb	0.405	0.341	1.105	6.273	.000**
Ht	0.359	0.289	3.152	5.150	.001**
MCV	0.065	-0.036	4.894	0.644	.667
MCH	0.106	0.008	1.868	1.087	.380
MCHC	0.201	0.114	0.792	2.315	.059

**p<0.05, **p<0.01.Age, gender, HS, SS, LS, and TS were entered as independent variables.*

Table5. Associations between anemia-related parameters and physical activity by linear regression analysis

Dependent variable	Variables	β	t-value	p
RBC P=0.027	Age	-.252	-1.843	.072
	Gender	-.444	-3.099	.003**
	HS	.440	2.309	.026*
	LS	-.040	-.302	.764
	TS	-.283	-1.527	.134
Hb P=0.000	Age	-.302	-2.509	.016*
	Gender	-.629	-4.986	.000**
	HS	.456	2.718	.009**
	LS	-.107	-.924	.360
	TS	-.338	-2.070	.044*
Ht P=0.001	Age	-.331	-2.647	.011*
	Gender	-.577	-4.410	.000**
	HS	.416	2.387	.021*
	LS	-.082	-.682	.499
	TS	-.294	-1.734	.090
MCV P=0.667	Age	-.032	-.210	.835
	Gender	-.106	-.673	.504
	HS	-.253	-1.204	.235
	LS	-.074	-.512	.611
	TS	.133	.648	.520
MCH P=0.380	Age	-.031	-.208	.836
	Gender	-.272	-1.756	.086
	HS	-.060	-.289	.774
	LS	-.125	-.880	.383
	TS	-.009	-.043	.966
MCHC P=0.059	Age	-.005	-.034	.973
	Gender	-.422	-2.887	.006
	HS	.343	1.763	.085
	LS	-.142	-1.060	.295
	TS	-.284	-1.500	.140

**p<0.05, **p<0.01.*

Discussion

In this study, we found significant associations between physical activity and RBC, Hb, and Ht, but not with MCV, MCH, and MCHC, in elderly caregivers of patients with dementia. HS and gender were independent factors associated with RBC, Hb, and Ht; TS was an independent factor associated with Hb; and age was an independent factor associated with Hb and Ht.

Participants of this study were relatively healthy with anemia data falling within reference ranges. Caregivers accumulate fatigue [13] and stress [14] from daily caregiving, and unhealthy conditions can lead to poor sleep [15] and anemia [16]. Our participants may have experienced physical fatigue and emotional stress due to caregiving, but their sleep may have been relatively stable. In general, these health conditions can negatively impact caregivers' quality of life [17]. Therefore, it will be important to create an environment in which caregivers can maintain their health.

Age was identified as an independent factor associated with Hb and Ht. Aging decreases hematopoietic function, making anemia more likely in elderly people. Age-related hematopoietic changes may have clinical consequences, such as an attenuated immune response and decreased blood cell counts [18]. There is growing evidence that anemia in elderly people may also be associated with bone fragility [19].

Older age was associated with lower Hb in the present study, possibly due to decreased bone marrow function with age, decreased erythropoiesis, and decreased sensitivity to hormones that stimulate erythrocytes.

Anemia in elderly people often results from a combination of various causes [20]. The main causes of anemia in

elderly people include nutritional disorders and inflammation, the former of which results from eating less and absorbing nutrients less well, resulting in an inadequate intake of iron, vitamin 12, folic acid, and other nutrients needed to build red blood cells [21]. In addition, protein under nutrition leads to anemia, decreased strength, and immune disorders [22]. Caregiver diets may change as they age and become deficient in nutrients. Given that elderly people may feel less hungry and eat less due to decreased activity, they should consume a moderate amount of animal products and maintain a well-balanced diet to prevent anemia.

Physical changes, such as those in the levels of cytokines, interfere with iron absorption due to infection and inflammation [23], and multiple medications can reduce erythropoietin secretion due to decreased renal function, making it difficult to produce red blood cells [24]. Participants of this study were in poorer physical condition than younger people, which may have made them more susceptible to chronic inflammatory diseases and thus more likely to be anemic.

Anemia in elderly people may be a risk factor or prognostic factor for exacerbating other diseases, such as cardiovascular disease [25]. A higher prevalence of anemia in elderly people with chronic diseases has been reported [26]. Anemia secondary to underlying diseases is often suspected, and efforts should be made to manage the underlying disease and detect it early.

In the present study, RBC, Hb, and Ht were significantly associated with anemia-related parameters and physical activity. HS and gender were independent factors associated with RBC, Hb, and Ht. In general, anemia-related parameters are lower in women than in men [27]. Male hormones stimulate the production of erythropoietin (a hematopoietic factor) in the kidneys, resulting in lower RBC, Hb, and Ht levels in women than in men [28].The prevalence of anemia is 7.7%, is higher in elderly people than in younger people, does not vary by sex, and is associated with aging and chronic disease [29]. On the other hand, higher Hb has been reported to improve physical performance in elderly people without anemia [30]. Low levels of iron in the body can cause anemia, and tissue iron deficiency can affect performance [31]. Since none of the participants of this study exhibited severe anemia, we speculate that the maintenance of physical function allowed them to carry out a combination of household activities with caregiving. Given that women reportedly contribute considerably more to household chores than men [32], it is possible that the large number of female caregivers in the present study continued to perform housework and thus maintained a relatively high level of physical activity, revealing a situation in which caregivers were physically and mentally occupied with both housework and caregiving. TS was also an independent factor associated with Hb. Caregiving activities are not rigorous, and thus less likely to increase intramuscular iron demand and result in iron loss through sweating.

Conclusion

Anemia-related parameters were associated with physical activity in caregivers of patients with dementia. This finding highlights the importance of maintaining hematopoietic function through adequate dietary management and nutritional status, the need to prevent infections and other health problems, and the need to prevent the onset or exacerbation of chronic diseases and minimize multiple drug use.

Given that anemia decreases general endurance and has a significant impact on respiratory and circulatory function, even if caregivers' anemia-related parameters were within reference ranges, they should be monitored over time with the aim of addressing lifestyle and disease factors (e.g., diet and sleep quality) that may cause anemia.

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