ORIGINAL ARTICLE

Cardiovascular Disease Risk Factors and the Relationships With Physical Activity, Aerobic Fitness, and Body Fat in Adolescents and Young Adults With Myelomeningocele

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ABSTRACT. Buffart LM, van den Berg-Emons RJ, Burdorf A, Janssen WG, Stam HJ, Roebroeck ME. Cardiovascular disease risk factors and the relationships with physical activity, aerobic fitness, and body fat in adolescents and young adults with myelomeningocele. Arch Phys Med Rehabil 2008;89:2167-73.

Objectives: To describe cardiovascular disease (CVD) risk factors in adolescents and young adults with myelomeningocele (MMC) and to explore relationships with physical activity, aerobic fitness, and body fat.

Design: Cross-sectional study.

Setting: Outpatient clinic.

Participants: Adolescents and young adults (N=31) with MMC (58% men) age 16 through 30 years; 13 were ambulatory and 18 were nonambulatory.

Interventions: Not applicable.

Main Outcome Measures: We studied biologic and lifestyle-related CVD risk factors, including lipid and lipoprotein profiles, blood pressure, aerobic fitness ($\dot{V}O_2$peak), body fat, daily physical activity, and smoking behavior. We considered subjects at increased CVD risk when 2 or more of the following risk factors clustered: systolic blood pressure, total serum cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), and cigarette smoking. Relationships were studied using regression analyses.

Results: Levels of TC, low-density lipoprotein cholesterol, and triglycerides were elevated in 29%, 38%, and 3% of the participants, respectively. HDL-C was reduced in 19%. Hypertension was found in 20%, and 19% were current cigarette smokers. Based on the clustering of risk factors, 42% of the participants were at increased CVD risk: 15% of ambulatory participants and 61% of nonambulatory participants (P=.03). Adjusted for sex and ambulatory status, participants with higher aerobic fitness tended to be more likely to have no CVD risk (odds ratio=13.0; P=.07). CVD risk was not associated to physical activity and body fat.

Conclusions: A large proportion of the study sample was at CVD risk, indicated by clustering of risk factors. Improving aerobic fitness in young adults with MMC may contribute in reducing CVD risk; this needs to be confirmed in future studies.

Key Words: Cardiovascular diseases; Physical fitness; Rehabilitation; Risk factors; Spina bifida cystica.

LIFESTYLE-RELATED DISEASES such as CVDs are of major concern in industrialized countries.[1,2] Although the clinical manifestations of CVD typically appear in adulthood, the process of atherosclerosis, causing CVD, lies early in childhood[3,4] and seems to increase rapidly during adolescence and young adulthood.[5] During the transition from adolescence to adulthood, people develop their own lifestyles. It may therefore be important to encourage healthy lifestyle behavior at these ages with the aim of delaying the development of atherosclerosis and reducing the incidence of CVD later in life.

The Framingham Heart Study has substantially contributed to the understanding of the causes of CVD and has identified numerous risk factors, such as cigarette smoking, hypertension, high TC, and low levels of HDL-C.[1,6-8] It has been suggested to focus on multiple risk factors rather than on 1 specific risk factor because the severity of atherosclerosis increases as the number of CVD risk factors increases.[4] This clustering of risk factors has proved to be a better measure of cardiovascular health in youth than single risk factors.[9]

Other important risk factors for CVD are physical inactivity, obesity, and low aerobic fitness,[6,7,10-12] which can play a major role in the prevention of CVD.[6] Persons with chronic physical conditions may be at increased risk of developing CVD. Unfavorable CVD risk profiles in persons with an SCI have been

List of Abbreviations

CVD	cardiovascular disease
DBP	diastolic blood pressure
HDL-C	high-density lipoprotein cholesterol
JNC 7	Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure
LDL-C	low-density lipoprotein cholesterol
MMC	myelomeningocele
NCEP ATP III	National Cholesterol Education, Adult Treatment Panel III
OR	odds ratio
$\dot{V}O_2$peak	peak oxygen uptake
RC	regression coefficient
SBP	systolic blood pressure
SCI	spinal cord injury
TC	total serum cholesterol
TG	triglycerides

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Supported by Johanna Children's Fund, Arnhem, The Netherlands (grant no. 20000005/20000158).

No commercial party having a direct financial interest in the results of the research supporting this article has or will confer a benefit on the authors or on any organization with which the authors are associated.

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Published online October 2, 2008 at *www.archives-pmr.org*.

0003-9993/08/8911-00191$34.00/0
doi:10.1016/j.apmr.2008.04.015

associated with inactive lifestyles and low aerobic fitness.[13-15] Furthermore, CVD is among the most important causes of death in persons with SCI,[16-18] occurring with a greater frequency than in the general population.[19] Also, persons with MMC have inactive lifestyles, low aerobic fitness, and excessive body fat.[20-24] Because they may be restricted in physical activity from birth, the risk of developing CVD may even be higher than in persons with an SCI. Furthermore, deteriorating vascular properties in the lower extremities (small diameter, low flow, high shear stress), which are related to CVD, tend to be more pronounced in persons with MMC than persons with SCI.[25] Because many persons with MMC nowadays survive into adulthood,[26] CVD may be of increasing concern.

In contrast with the SCI population, no data are available on the number of deaths caused by CVD in persons with MMC, and information on CVD risk factors other than physical inactivity, poor aerobic fitness, and obesity is limited. Rendeli et al[27] found that girls with MMC (age 1–16y) had higher levels of TC and very low-density lipoprotein than their peers, and TC was higher in nonambulatory than in ambulatory girls. In contrast, Nelson et al[28] did not find differences in lipid and lipoprotein profiles between adolescents with MMC and able-bodied peers. Because of the scarcity of studies, the present study aimed to describe CVD risk factors in adolescents and young adults with MMC, including ambulators and nonambulators. To study whether improving lifestyles might benefit cardiovascular health, we explored whether physical activity, aerobic fitness, and body fat were related to other CVD risk factors.

METHODS

Participants

Recruitment. Adolescents and young adults with MMC (age 16–30y) from 4 university hospitals in the western part of The Netherlands (Rotterdam, Leiden, Utrecht, and Amsterdam) and 5 rehabilitation centers in the adjacent region were invited to participate in a cross-sectional study on physical activity and aerobic fitness. Exclusion criteria were complete dependence on an electric wheelchair, inability to understand the instructions necessary for the study, presence of disorders other than MMC that affected daily physical activity (eg, rheumatoid arthritis), and presence of disorders that contraindicated a maximal exercise test (eg, exercise-induced ischemia or arrhythmias, uncontrolled hypertension, and exercise limitation caused by chronic obstructive pulmonary disease). The inclusion criterion was willingness to undergo blood tests. In total, 31 adolescents and young adults participated in the present study, a subset of a larger cross-sectional study (n=51) on physical activity and fitness in adolescents and young adults with MMC.[24,29] All participants gave written informed consent. The Medical Ethics Committee of Erasmus Medical Center and of all participating institutes approved the study.

Characteristics. The mean age of the participants was 21.4±4.4y, and 18 (58%) were men. We obtained level of lesion and the presence of hydrocephalus from medical records. We defined ambulatory status according to the classification of Hoffer et al,[30] and categorized participants as ambulators (community ambulators, n=8; or household ambulators, n=5) or nonambulators (n=18, also including nonfunctional ambulators).[30]

Personal and condition-related characteristics (ie, age, sex, level of lesion, and presence of hydrocephalus), ambulatory status, blood pressure, sum of 4 skin folds, aerobic fitness, daily physical activity, and smoking behavior did not differ between those who were willing to yield a blood sample (n=31) and those who were not (n=20), as tested with an independent *t* test or Chi-square test (table 1). Furthermore, we found no differences in personal and disease-related characteristics of responders (n=51) and nonresponders of the larger cross-sectional study (n=108).[24]

Table 1: Descriptive Results of Personal and Condition-Related Characteristics, and Biologic and Lifestyle-Related Risk Factors of Cardiovascular Disease of Responders and Nonresponders of This Study

	Responders (n=31)	Nonresponders (n=20)	
Personal and condition-related characteristics	n (%)	n (%)	*P*
Sex (female)	13 (42)	10 (50)	.77
Ambulatory status (nonambulator)	18 (58)	10 (50)	.78
Lesion level			.37
Sacral	2 (7)	5 (25)	
Lumbosacral	14 (45)	7 (35)	
Lumbar	10 (32)	5 (25)	
Thoraco-lumbar	4 (13)	3 (15)	
Thoracic	1 (3)	0 (0)	
Hydrocephalus	25 (81)	17 (89)	.50
	Mean ± SD	Mean ± SD	*P*
Age (y)	21.4±4.4	20.6±4.8	.55
Biologic risk factors			
Blood lipid and lipoproteins			
Total cholesterol (mmol/L)	4.59±0.94	NA	
High-density lipoprotein (mmol/L)	1.27±0.25	NA	
Low-density lipoprotein (mmol/L)	2.96±0.93	NA	
TG (mmol/L)	1.09±0.32	NA	
Blood pressure			
SBP (mmHg)	123.9±13.2*	122.0±37.5	.55
DBP (mmHg)	80.9±8.6*	80.5±5.6	.88
Body fat, sum of 4 skin folds (mm)	75.4±40.6*	72.4±37.5*	.70
Aerobic fitness, Vo_2peak (L/min)	1.47±0.51	1.51±0.56	.79
Lifestyle-related risk factors			
Daily physical activity (min/d)	77.4±72.1†	85.7±45.5	.65
Smoking behavior (cigarettes/d)	2.0±4.9	0.6±2.4	.25

Abbreviations: NA, not applicable.
*n−1.
†n−2.

Biologic Risk Factors

Blood lipids and lipoproteins. Nonfasting venous blood samples of approximately 10mL were drawn from the vena antecubitus with a Vacutainer needle[a] and collected into an evacuated serum separator tube II (SST II tube[a]) while subjects were seated. TC and TG were determined using an enzymatic calorimetric test (CHOD-PAP and GPO-PAP[b]). HDL-C and LDL-C were determined directly using a homogeneous enzymatic calorimetric test with polyethylene glycol modified enzymes and dextran sulfate (Roche/Hitachi 747, 902[b]).

Blood pressure. We measured blood pressure with an indirect method while subjects were seated for at least 10 minutes prior to the measurement. A standard pressure cuff was placed around the upper arm. SBP and DBP were measured twice