VOLUME 59 - No. 2 - FEBRUARY 2019

THE JOURNAL OF SPORTS MEDICINE AND PHYSICAL FITNESS

PUBBLICAZIONE PERIODICA MENSILE - POSTE ITALIANE S.P.A. - SPED. IN A. P. D.L. 353/2003 (CONV. IN L. 27/02/2004 N° 46) ART. 1, COMMA 1, DCB/CN - ISSN 0022-4707 TAXE PERÇUE

PUBLISHED BY MINERVA MEDICA

Online version at http://www.minervamedica.it

The Journal of Sports Medicine and Physical Fitness 2019 February;59(2):335-9
DOI: 10.23736/S0022-4707.18.08221-X

ORIGINAL ARTICLE
EXERCISE AND SPORT CARDIOLOGY

Effects of a one-week vacation with various activity programs on cardiovascular parameters

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ABSTRACT

BACKGROUND: A vacation is considered essential to achieve recovery from the stress of work. Knowledge about the potential health effects of holidays is scarce. The East Tyrolean Health Tourism Study is an open comparative study to investigate the cardiovascular effects of a one-week vacation with different activities on healthy vacationers.
METHODS: Fifty-two healthy vacationers spending one week in East Tyrol participated in two types of vacation activities (golf *versus* Nordic walking or e-biking [NW&EB]). In the former group 30 subjects played golf for 33.5 h/week, and in the NW&EB group 22 engaged in Nordic walking or e-biking for 14.2 h/week. Cardiovascular parameters such as performance capacity, blood pressure, heart rate profiles and cardiac diastolic function were measured by a cardiopulmonary exercise test, Holter ECG and echocardiography performed one day before and after the stay.
RESULTS: There was a significant decrease in body weight of 1.0 kg in the NW&EB-group but not in the golf group. In both groups we noted a reduction of blood pressure and heart rate, which was marked and significant only in the golf group. We observed no significant changes in performance capacity but did note an improvement of cardiac diastolic function in both groups; the improvement was more pronounced in the NW&EB group.
CONCLUSIONS: A one-week vacation with an activity program for several hours per week is well tolerated by healthy vacationers and improves cardiovascular parameters. The cardiovascular benefits were homogeneous but differed in their magnitude, depending on the activity group. The benefits were probably due to the enhanced physical activity rather than purely a holiday effect.

(*Cite this article as:* Neumayr G, Lechleitner P. Effects of a one-week vacation with various activity programs on cardiovascular parameters. J Sports Med Phys Fitness 2019;59:335-9. DOI: 10.23736/S0022-4707.18.08221-X)

KEY WORDS: Golf - Walking - Bicycling - Health resorts - Cardiovascular system.

Vacation, as defined by Lounsbury and Hoops in 1986, is a temporary respite from work for several days or weeks. Workers need to take time off to recover from the strain of their workaday lives. To what extent the duration of a vacation and the activities therein have an impact on health and wellbeing remains unclear because we lack scientific measurements of physiological parameters before, during, and after a vacation.[1]

Current holiday behavior reveals a tendency towards several short-term vacations not exceeding one week. Whether a break of just one week has perceivable health effects is currently unknown. The potential health effects of vacation activities also remain unclear.[1] Activity programs such as playing golf, Nordic walking, or riding a bicycle with electric motor support (e-biking) are known for their low to moderate exercise intensity and therefore feasible for nearly everybody, including persons with poor cardiorespiratory fitness. Such vacation activities might accelerate the recovery process and enhance the potential health effects of a short-term vacation. The degree of regeneration can be measured by cardiovascular parameters such as blood pressure, heart rate, performance capacity, and cardiac diastolic function.[2]

There is much evidence that a rehabilitation stay of several weeks has beneficial effects in cardiovascular patients, but no data exist on the short-term cardiac effects of

a one-week vacation, with an activity program, in healthy subjects.

The project associated with the East Tyrolean Health Tourism Study was initiated in 2013 by the Tyrolean Government. It is an open comparative study to investigate the effects of a one-week vacation with different activity programs on various cardiovascular parameters in healthy vacationers.

Materials and methods

Study participants

Fifty-two healthy vacationers spending a week at one of eight hotels in East Tyrol (670-980 meters above sea level) participated in the study. The East Tyrolean Health Tourism Study was approved by the ethics committee of the Leopold Franzens University of Innsbruck. All participants provided their written informed consent prior to the study.

Three activity programs were available, *i.e*. golf, Nordic walking, and e-biking. The subjects were divided into two groups. The first was the golf group (N.=30) and the second a combined Nordic walking and e-biking-group (NW&EB group, N.=22). Nordic walking and e-biking were grouped together because of similarities in the duration and intensity of exercise. Assignment to the groups was based on the vacationer's preference. Activities were performed daily for six of seven days. Participants were free to take a day off once a week. Members of the golf group played golf for 33.5 h/week while members of the NW&EB group exercised for 14.2 h/week, performing six Nordic walking or e-biking tours (the mean duration of a tour was ~2.4 hours) guided by fitness instructors. There were no dietary targets and no individual measurements of caloric intake. In their holidays, all subjects were free to eat what they wanted according to their eating habits and the menu of the hotel.

Cardiovascular parameters

Cardiovascular parameters and cardiac blood markers (NT-proBNP and hsTnT) were investigated one day before and after the stay. Blood pressure was measured at rest and during the exercise test. Performance capacity was assessed by an incremental 25-W, 2-minute symptom-limited maximal exercise test performed on a cycle ergometer Ergobike Medical 8i (Daum Electronic®, Fürth, Germany). Minute BTPS ventilation ($\dot{V}E$), STPD oxygen uptake ($\dot{V}O_2$) and STPD carbon dioxide production ($\dot{V}CO_2$) were measured by performing an open circuit spirometry (ZAN600 CPET®, Oberthulba/Germany, Germany). All patients underwent a 24-hour ECG (Medilog AR 12 plus®, Schiller, Feldkirchen, Germany). Heart rate profiles and the number of premature ventricular (PVC) and supraventricular contractions were determined. Left ventricular diastolic function was evaluated by echocardiography (Vivid 7®; GE Healthcare, Vienna, Austria). We investigated transmitral flow parameters, including early (E) and late (A) diastolic filling velocities, the E/A ratio, and the E deceleration time (DT) from an apical four-chamber view with conventional pulsed-wave Doppler. The E/e' ratio was measured by tissue Doppler imaging. Furthermore, we assessed the left ventricular Tei index (LV-Tei) as a myocardial performance index, tricuspid regurgitation velocity, left ventricular ejection fraction (Simpson rule), and right ventricular function (TAPSE). All laboratory analysis were performed with routine methods at the Hospital of Lienz. The cardiovascular parameters NT-pro brain natriuretic peptide (NT-proBNP) and high sensitive troponin T (hs TnT) were analyzed by Elecsys NT-pro BNP and Elecsys Troponin high sensitive, provided by Roche Diagnostics (Vienna, Austria).

Statistical analysis

All analyses were performed with the SPSS software package v. 9.0 (Chicago, IL, USA). Results are expressed as medians with interquartile ranges. For comparison of variables between groups we used the Mann-Whitney test. Changes over the time were calculated by the Wilcoxon test. The level of statistical significance was set to $P<0.05$.

Results

Study participants

The study population comprised 30 men and 22 women. The two groups consisted of 30 golfers and 22 persons in the combined Nordic walking (N.=11) and e-biking group (N.=11). The mean age of the participants was 54.3 years; baseline characteristics are summarized in Table I. No significant differences existed between the groups. Post-vacation only the NW&EB group experienced a significant decrease of 1.0 kg in body weight.

Cardiovascular parameters

Data pertaining to cardiovascular parameters are given in Table II. In the golf group and the NW&EB group, the median absolute maximum power output (W_{max}) was 150

TABLE I.—*Baseline characteristics of the study participants.*

Demographics	Golf group (N.=30)	NW&EB group (N.=22)	P value
Age, years	54 (47-63)	58 (46-61)	0.85
Sex, male	53%	64%	0.57
Body weight before vacation, kg	83 (71-96)	86 (62-104)	0.79
Body weight after vacation, kg	83 (71-94)	85 (62-104)	0.03
Body Mass Index, kg/m^2	26 (23; 30)	26 (22; 34)	0.91
Body fat, %	24.5 (20.5; 35.8)	25.4 (17.5; 37.6)	0.85
Time under stress, h	33.5	14.2	<0.001

Results are expressed as medians and interquartile ranges.

TABLE II.—*Cardiovascular parameters in the golf group and the Nordic walking plus e-biking group (NW&EB group) one day before and after vacation.*

Parameters	Golf group		NW&EB group	
	Before vacation	After vacation	Before vacation	After vacation
Resting HR_{mean}	81 (73-93)	77 (75-84)**	81 (76-87)	76 (70-86)
HR_{100W}	123 (108-136)	112 (104-137)*	116 (105-132)	112 (98-133)
HR_{max}	156 (142-165)	155 (142-165)	155 (143-164)	155 (137-169)
SBP_{rest}	130 (117-135)	119 (111-128)*	125 (114-136)	122 (111-142)
DBP_{rest}	80 (73-84)	75 (69-77)*	84 (78-87)	81 (74-84)
SBP_{100W}	162 (148-184)	153 (131-180)*	143 (136-182)	140 (130-170)
W_{max}	150 (124-199)	151 (128-184)	175 (125-216)	172 (132-229) *
VO_{2max}, mL/kg/min	26 (23-35)	26 (21-34)	28 (25-35)	28 (21-35)
LV-Tei	0.61 (0.50-0.69)	0.51 (0.44-0.64)	0.51 (0.44-0.64)	0.45 (0.35-0.56)***
E/e' ratio	8.0 (6.4-9.5)	7.8 (6.4-8.5)	7.8 (6.9-10.1)	7.4 (6.7-8.3)*
NT-proBNP	74 (32-101)	62 (43-88)	44 (31-80)	46 (26-99)
hs TnT	4 (2-5)	3 (2-6)	3 (2-7)	4 (2-7)
hs CRP	0.12 (0.06-0.34)	0.27 (0.07-0.41)	0.12 (0.07-0.18)	0.15 (0.08-0.2)
CPK	135 (87-188)	133 (112-262)	96 (73-126)	120 (85-193)
24h-HR_{mean}	85 (79-91)	82 (76-87)	81 (77-87)	76 (71-84)
PVCs/h	14 (7-27)	14 (8-50)	21 (6-44)	9 (3-20)

HR: heart rate; SBP: systolic blood pressure; DBP: diastolic blood pressure; $\dot{V}O_{2max}$: maximal oxygen consumption; LV-Tei: left ventricular Tei index; NT-proBNP: NT-pro brain natiuretic peptide; hs TnT: high-sensistive troponin T; hs CRP: high-sensitive C-reactive protein; CPK: creatine phosphokinase; 24h-HR_{mean}: mean heart rate by 24-hour ECG; PMCs/h: premature ventricular contractions per hour.
Within the group: *vs*. before vacation *P<0.01; *vs*. before vacation **P<0.005; *vs*. before vacation ***P<0.001.

W and 175 W, respectively, while the median values of relative maximum power output were 1.8 and 2.0 W_{max}/kg, respectively.

After a one-week vacation there was no change in maximal performance in the golf group, and a very small but significant decrease of 1.7% in the NW&EB group (P<0.01), with an unchanged relative maximum power output (2.0 W_{max}/kg) because of the simultaneous weight loss. Although the maximal power output did not change essentially, there were reductions in heart rate, systolic and diastolic blood pressure at the submaximal work load of 100 W, which were significant only in the golf group.

The vacation reduced blood pressure and heart rate in both groups. The reduction in systolic (-11.0 mmHg) and diastolic blood pressure (-5.0 mmHg) was pronounced and significant in the golf group (P<0.01), while the reductions in systolic and diastolic blood pressure were -3.0 and -3.0 mmHg, respectively, in the NW&EB group. Mean heart rates recorded by Holter ECG decreased by 3 bpm in the golf group and 5 bpm in the nwb&eb group, with unchanged characteristics in circadian heart rate profiles. At the submaximal work load of 100 W, the reduction in heart rate was 11 bpm in the golf group (P<0.01) and 4 beats/min in the NW&EB group. The number of ventricular and supraventricular premature contractions were also similar in the two groups and stable between the two points of time.

Echocardiography revealed no changes in left ventricular systolic function as expected, but a significant improvement in diastolic function in the NW&EB group, with a clear decrease in the E/e' ratio and the left ventricular Tei index. The corresponding reductions in the golf group were less distinct and non-significant (Table II).

There were no significant changes in the cardiac blood markers NT-proBNP and hsTnT. The results of the laboratory parameters investigated and of 24-hour ECG monitoring are given in Table II.

Discussion

The main findings of the East Tyrolean Health Tourism Study (cardiovascular section of the study) were the following: 1) a one-week vacation with physical activities of moderate intensity for several hours was safe and well tolerated by healthy vacationers; 2) after just one week of active vacation there were significant changes in cardiovascular parameters, though to a varying degree, in the various activity groups.

The effort recovery theory implies that chronic load reactions at work may develop into pathologic conditions (such as prolonged fatigue, high blood pressure, insomnia) when recovery during time off is incomplete.[3] Vacation is a form of macrorecovery and is likely to be a more powerful recovery opportunity than regular free evenings or weekends because of two underlying mechanisms. The first passive mechanism is a direct release from job demands, the second is an active one expressed by spending time on valued non-work activities of one's own choice, such as hobbies, family, or sports. An assumption of our study was that a vacation with an activity program might provide earlier and more complete recovery than that achieved by a simple holiday. In sports as well, active recovery with low intensities at a work rate <30% of VO_2max accelerates the regeneration process by faster lactate degradation in comparison to passive recovery in sedentary subjects.[4]

Playing golf, Nordic walking or e-biking are very popular sports not only in Austria. Golf attracts about 80 million individuals worldwide and is considered very healthy in terms of reducing mortality and prolonging life by up to 5 years.[5] Nordic walking or hiking in mountainous areas is also an activity of low to moderate exercise intensity, feasible even for patients with metabolic syndrome, as observed in the AMAS 2000 study.[6] E-biking enables even untrained persons to cycle up mountains and long distances in flat terrain by the use of a connectable electric motor.

The East Tyrolean Health Tourism Study was performed to determine whether a one-week active vacation has beneficial cardiovascular effects. The subjects were divided into a golf group and an NW&EB group because the profile of muscle strain and metabolic energy demands differ between the two groups but resemble one another within the NW&EB group. In contrast to Nordic walking and e-biking, golf exerts significant strain on isometric muscles and is associated with significantly lower energy demands (3-4 METs *versus* 5-6 METs in the NW&EB group).[7]

Both groups experienced a reduction in systolic and diastolic blood pressure. In the NW&EB group, systolic blood pressure was reduced by 3.0 mmHg and diastolic blood pressure by 3.0 mmHg, which is very similar to the results of a large meta-analysis by Fagard in which the weighted net reduction of systolic and diastolic blood pressure in response to dynamic physical training averaged 3.4/2.4 mmHg.[8] The reduction of blood pressure was much more pronounced in the golf group because of extensive isometric handgrip training in golf. The mean reduction in blood pressure in the golf group was 11.0/5.0 mmHg, which is similar to the results of a recent meta-analysis by Cornelissen in which isometric handgrip training was shown to reduce blood pressure very effectively by 13.5/6.1 mmHg.[9]

The active vacation also lowered heart rate in both groups. The median reduction was 3 bpm in the golf group and 5 bpm in NW&EB group, with unchanged characteristics in circadian profiles and unchanged numbers of ventricular and supraventricular premature beats. The reduction in heart rate was very similar to the findings in the AMAS 2000 trial.[6]

In addition, the assessment of left ventricular diastolic function revealed an improvement in diastolic function in both groups, which was significant in the NW&EB group, with a clear decrease in the E/e' ratio and the left ventricular Tei index. We assume that the improved ventricular filling in the NW&EB group was due to the greater exercise intensity of Nordic walking and e-biking compared to golf.[10]

Nordic walking and e-biking were more effective for weight control than playing golf. Possibly due to a different energy input and higher exercise intensities with enhanced energy demands, these activities caused a significant body weight reduction of 1 kg in the NW&EB group. Performance capacity did not change in either group. Marked improvements in fitness obviously require longer training periods and more individualized training.

Conclusions

In conclusion, the data of the East Tyrolean Health Tourism Study prove that a one-week vacation with an activity program is well tolerated by healthy vacationers and induces several improvements in cardiovascular parameters. A one-week vacation with an activity program may be recommended as an excellent recovery program for cardiovascular regeneration.

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Conflicts of interest.—The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Funding.—The project was supported by the Tyrolean Government, the East Tyrolean Tourist Board, the participating hotels in East Tyrol (Dolomitengolfhotel und Spa, Golfhotel Suites, Grandhotel Lienz, Hotel Moarhof, Hotel Ansitz Haidenhof, Hotel Outside, Hotel Traube, Hotel Rauter), and the Hospital of Lienz.

Authors' contributions.—Günther Neumayr performed data collection, analysis and interpretation of data, drafted and revised the paper. Peter Lechleitner participated in study design, data collection, analysis and interpretation of data, and paper revision.

Acknowledgements.—The authors wish to thank Dr. Michael Edlinger and Prof. Hanno Ulmer from the Department of Medical Biostatistics, University of Innsbruck, Austria, for providing support in statistical calculations.

Article first published online: March 1, 2018. - Manuscript accepted: February 8, 2018. - Manuscript revised: January 29, 2018. - Manuscript received: September 29, 2017.