Supplementary material

KRZYSZTOF SMARŻ, TOMASZ JAXA-CHAMIEC, TOMASZ CHWYCZKO, et al. CARDIOPULMONARY EXERCISE TESTING IN ADULT CARDIOLOGY – EXPERT OPINION OF THE WORKING GROUP OF CARDIAC REHABILITATION AND EXERCISE PHYSIOLOGY OF THE POLISH CARDIAC SOCIETY. Kardiol Pol. 2019; 77: 730-756. doi:10.33963/KP.14889

Table S1 Parameters of cardiopulmonary exercise test relevant for prognosis (mortlity) and length of hospital stay in patients after various types of surgery

Types of surgery and references	**Number of patients, n**	**Mortality**					**Hospital stay**	
		In-hospital	**30-day**	**90-day**	**One-year**	**≥2 years**	**All**	**ICU**
Liver transplant								
Bernal et al. (2014)[1]	223				VO_2-AT 9,8 (worse prognosis) vs. 11,7 (better prognosis) ml/kg/min		VO_2-AT <9,2 ml/kg mc./min	VO_2peak <13,4 ml/kg mc./min

Dunne et al. (2014)[2]	197	–	–	–	–	–	VO_2-AT i VO_2peak (l/min)	
Epstein et al. (2004)[3]	59	–	–	(100 dni) % VO_2pred <60% % VO_2-AT <50%	–	-		
Neviere et al. (2014)[4]	263				VO_2peak; 18,6 (better prognosis) vs. 17,1 (worse prognosis) ml/kg mc./min			

Prentis et al. (2012)[5]	60		VO_2-AT <9,0 ml/kg mc./min					VO_2-AT <11 ml/kg mc./min
Other liver and bile ducts surgery								
Kaibori et al. (2013)[6]	61					VO_2-AT <11,5 ml/kg mc./min		
Junejo et al. (2012)[7]	94		VO_2-AT <9,9 ml/kg mc./min					VO_2-AT <9,9 ml/kg mc./min
Major abdominal surgery (other than the above)								
Older (1999)[8]	548					VO_2-AT <11 ml/kg mc./min		

Snowden et al. (2013)[9]	389	VO_2-AT <10 ml/kg mc./min					VO_2-AT <10 ml/kg mc./min	VO_2-AT <10 ml/kg mc./min
Wilson et al. (2010)[10]	847		VO_2-AT <10,9 ml/kg mc./min VE/VC O_2 >34				VO_2-AT <11 ml/kg mc./min	
Vascular surgery of abdominal aortic aneurysm								
Grant et al.[11]	506					VO_2peak <15 ml/kg mc./min, VE/VCO_2 at AT >42		

Hartley et al.[12]	415		VO_2-AT <10,2 ml/kg mc./min	VO_2peak <15 ml/kg mc./min				
Pancreatic surgery								
Junejo et al.[13]	64		VE/VC O_2 at AT >41					

Abbrevations: AT – anaerobic threshold; ICU – intensive care unit; VO2-AT – oxygen uptake at anaerobic threshold; VO_2peak – oxygen uptake at peak exercise; VE – minute ventilation; VCO_2 – carbon dioxide output

References for Table S1

1. Bernal W, Martin-Mateos R, Lipcsey M, et al. Aerobic capacity during cardiopulmonary exercise testing and survival with and without liver transplantation for patients with chronic liver disease. Liver Transpl. 2014; 20: 54-62.

2. Dunne DF, Jones RP, Lythgoe DT, et al. Cardiopulmonary exercise testing before liver surgery. J Surg Oncol. 2014; 110: 439-444

3. Epstein SK, Freeman RB, Khayat A, et al. Aerobic capacity is associated with 100-day outcome after hepatic transplantation. Liver Transpl 2004; 10: 418-424.

4. Neviere R, Edme JL, Montaigne D, et al. Prognostic implications of preoperative aerobic capacity and exercise oscillatory ventilation after liver transplantation. Am J Transplant. 2014; 14: 88-95.

5. Prentis JM, Manas DM, Trenell MI, et al. Submaximal cardiopulmonary exercise testing predicts 90-day survival after liver transplantation. Liver Transpl. 2012; 18: 152-159.

6. Kaibori M, Ishizaki M, Matsui K, et al. Assessment of preoperative exercise capacity in hepatocellular carcinoma patients with chronic liver injury undergoing hepatectomy. BMC Gastroenterol. 2013; 13: 119.

7. Junejo MA, Mason JM, Sheen AJ, et al. Cardiopulmonary exercise testing for preoperative risk assessment before hepatic resection. Br J Surg 2012; 99: 1097-1104.

8. Older P, Hall A, Hader R. Cardiopulmonary exercise testing as a screening test for perioperative management of major surgery in the elderly. Chest 1999; 116: 355-362.

9. Snowden CP, Prentis JM, Anderson HL, et al. Submaximal cardiopulmonary exercise testing predicts complications and hospital length of stay in patients undergoing major elective surgery. Ann Surg. 2010; 251: 535-541.

10. Wilson RJT, Davies S, Yates D, et al. Impaired functional capacity is associated with all-cause mortality after major elective intra-abdominal surgery. Br J Anaesth. 2010; 105: 297-303.

11. Grant SW, Hickey GL, Wisely NA, et al. Cardiopulmonary exercise testing and survival after elective abdominal aortic aneurysm repair. Br J Anaesth. 2015;114:430-436.

12. Hartley RA, Pichel AC, Grant SW, et al. Preoperative cardiopulmonary exercise testing and risk of early mortality following abdominal aortic aneurysm repair. Br J Surg. 2012; 99: 1539-1546.

13. Junejo MA, Mason JM, Sheen AJ, et al. Cardiopulmonary exercise testing for preoperative risk assessment before pancreaticoduodenectomy for cancer. Ann Surg Oncol. 2014; 21: 1929–36.

Table S2 Categories of aerobic capability characterised by maximum oxygen uptake [ml/kg/min] for adult healthy women, depending on age

Age [years]	**Categories of aerobic capability VO_2max [ml/min mc./kg]**					**Mean values of maximum oxygen uptake VO_2max [ml/kg mc./min]**		
	Very low	**Low**	**Moderate**	**Good**	**Very good**	Fletcher[4]	Wasserman[5]	Kaminsky[6]
20–29						36 ±6,9	33,3	37,6 ±10,2
AHA[1]	≤23	24-30	31-37	38-48	≥49			
Cooper Institute[2]	≤31	32–35	36–39	40–43	≥44			
Astrand[3]	≤28	29–34	35–43	44–48	≥49			
30–39						34 ±6,2	30,3	30,9 ±8,0
AHA	≤19	20–27	28–33	34–44	≥45			

Cooper Institute	≤29	30–33	34–37	38–41	≥42			
Astrand	≤27	28–33	34–41	42–47	≥48			
40–49						32 ±6,2	27,4	27,9 ±7,7
AHA	≤16	17–23	24–30	31–41	≥42			
Cooper Institute	≤28	29–32	33–35	36–39	≥40			
Astrand	≤25	26–31	32–40	41–45	≥46			
50–59						29 ±5,4	24,5	24,2 ±6,1
AHA	≤14	15–20	21–27	28–37	≥38			
Cooper Institute	≤26	27–29	30–32	33–35	≥36			
Astrand	≤21	22–28	29–36	37–41	≥42			
60–69						27 ±4,7	21,6	20,7 ±5,0
AHA	≤12	13–17	18–23	24–34	≥35			
Cooper Institute	≤24	25–27	28–29	30–32	≥33			
Astrand (60–65 lat)	≤21	22–28	29–36	37–41	≥42			
70–79						27 ±5,8	18,7	18,3 ±3,6

Abbreviations: AHA – American Heart Association; VO2max – maximal oxygen uptake, average value from 10–60 s depending the protocol used

References for Table S2

1. American Heart Association. Committee on Exercise: Exercise testing and training of apparently healthy individuals: a handbook for physicians. Dallas, Tex: New York, American Heart Association; 1972.
1. The Cooper Institute. Physical Fitness Assessments and Norms for Adults and Law Enforcement 2013: 53-55; Relative values refer to women weighting 58 kg.
2. Astrand I. Aerobic work capacity in men and women with special reference to age. Acta Physiol Scand. 1960;49 (Suppl. 169); Original values in L/min were calculated to ml/kg/min with the assumption of body weight for women 58 kg.
3. Fletcher GF, Balady GJ, Amsterdam EA, et al. Exercise standards for testing and training: a statement for healthcare professionals from the American Heart Association. Circulation. 2001; 104: 1694-1740.
4. Wasserman K, Hansen JE, Sue DY, Stinger WW, Whipp BJ. Normal values. W: Wasserman K, Hansen JE, Sue DY, Stinger WW, Whipp BJ, red. Principles of exercise testing and interpretation: including pathophysiology and clinical applications. Philadelphia: Lippincott Williams &Wilkins; 2005: 160-182; Mean values for women with body weight 60 kg.
5. Kaminsky LA, Arena R, Myers J. Reference standards for cardiorespiratory fitness measured with cardiopulmonary exercise testing: Data from the fitness registry and the importance of exercise national database. Mayo Clin Proc. 2015; 90: 1515-1523.

Table S3 Categories of aerobic capability characterised by maximum oxygen uptake [ml/kg/min] for adult healthy men, depending on age								
Age [years]	**Categories of aerobic capability** **VO_2max [ml/min mc./kg]**					**Mean values of maximum oxygen uptake** **VO_2max [ml/kg mc./min]**		
	Very low	**Low**	**Moderate**	**Good**	**Very good**	Fletcher[4]	Wasserman[5]	Kaminsky[6]
20–29						43 ±7,2	43,3	47,6 ±11,3
AHA[1]	≤24	25–33	34–42	43–52	≥53			
Cooper Institute[2]	≤37	38–41	42–45	46–49	≥50			
Astrand[3]	≤38	39–43	44–51	52–56	≥57			
30–39						42 ±7,0	39,6	43,0 ±9,9
AHA	≤22	23–30	31–38	39–48	≥49			
Cooper Institute	≤35	36–40	41–44	45–47	≥48			
Astrand	≤34	35–39	40–47	48–51	≥52			
40–49						40 ±7,2	35,8	38,8 ±9,6
AHA	≤19	20–26	27–35	36–44	≥45			

Cooper Institute	≤34	35–38	39–41	42–45	≥46			
Astrand	≤30	31–35	36–43	44–47	≥48			
50–59						36 ±7,1	32,1	33,8 ±9,1
AHA	≤17	18–24	25–33	34–42	≥43			
Cooper Institute	≤31	32–35	36–38	39–42	≥43			
Astrand	≤25	26–31	32–39	40–43	≥44			
60–69						33 ±7,3	28,4	29,4 ±7,9
AHA	≤15	16–22	23–30	31–40	≥41			
Cooper Institute	≤27	28–32	33–35	36–38	≥39			
Astrand	≤21	22–26	27–35	36–39	≥40			
70–79						29 ±7,3	24,7	25,8 ±7,1
Abbreviations: AHA – American Heart Association; VO2max – maximal oxygen uptake, average value from 10–60 s depending the protocol used								
References for Table S3								

2. American Heart Association. Committee on Exercise: Exercise testing and training of apparently healthy individuals: a handbook for physicians. Dallas, Tex; New York: American Heart Association; 1972.
3. The Cooper Institute. Physical fitness assessments and norms for adults and law enforcement. 2013: 43-45; Relative values refer to men weighting 72 kg.
4. Astrand I. Aerobic work capacity in men and women with special reference to age. Acta Physiol Scand. 1960; 49 (Suppl. 169): 1-9; Original values in L/min were calculated to ml/kg/min with the assumption of body weight for men 72 kg.
5. Fletcher GF, Balady GJ, Amsterdam EA, et al. Exercise standards for testing and training. A statement for healthcare professionals from the American Heart Association. Circulation. 2001; 104: 1694-1740.
6. Wasserman K, Hansen JE, Sue DY, et al. Normal values. W: Wasserman K, Hansen JE, Sue DY, Stinger WW, Whipp BJ, red. Principles of exercise testing and interpretation: including pathophysiology and clinical applications. Philadelphia: Lippincott Williams &Wilkins; 2005: 160-182; Mean values for men with body weight 75 kg.
7. Kaminsky LA, Arena R, Myers J. Reference standards for cardiorespiratory fitness measured with cardiopulmonary exercise testing: data from the fitness registry and the importance of exercise national database. Mayo Clin Proc. 2015; 90: 1515-1523.