

General Force Guidelines

	Movement	Description	Maximal Exertion (kg)		Repetitive Use (kg)		Reference	
			Male	Female	Male	Female		
Upper Extremity (assume 2 handed unless stated)	Pull down	Above head height (hook grip)	55.1	38.6	38.6	27.0	Eastman Kodak, 1986* (pg. 390)	
		Above head height (power grip)	20.4	14.3	14.3	10.0		
		Shoulder level	32.1	22.5	22.5	15.7		
	Push down	Elbow height	29.3	20.5	20.5	14.4		
	Pull up	25 cm above floor	32.1	22.5	22.5	15.7		
		Elbow height	15.1	10.6	10.6	7.4		
		Shoulder height	7.7	5.4	5.4	3.8		
	Push up	Shoulder height	20.6	14.4	14.4	10.1		
	Pull down	Elbow @ 90 degrees	54.7	38.2	38.3	26.7		DTI, 2000** (pg. 272)
	Pull in	1570 mm above floor	29.7	25.1	20.8	17.6		[Keyserling et al, 1978]
	Push/Pull Lateral	Force across body w/ arm fully extended <i>* lateral force limits are 50-70% of forward/back forces limits.</i>	7.0		4.9			Kodak 1986 (Eastman Kodak 2004, pg. 559) and Rodgers et al., 1986 (Ferreira, 2004, pg. 22)
Press down	1120mm from floor, elbows @ 90 degrees	38.4	29.1	26.9	20.4	DTI, 2000** (pg 283) [Keyserling et al, 1978]		
Push forward (1 hand)	1 hand @ waist height	43.3	30.3	30.3	21.2	DTI, 2000** (pg. 267) [Hoag, 1980]		
	1 hand over head, arm vertical	7.1	5.0	5.0	3.5			
Hand/Fingers	Pulp pinch	Pad of thumb to pad of index finger	8.6	6.4	6.0	4.5	DTI, 2000**+ (pg. 289) [Crosby et al., 1994]	
	Chuck pinch	Pad of thumb to pads of index and middle finger	10.6	7.4	7.4	5.2	DTI, 2000** (pg. 290) [Mathiowetz et al., 1985]	
	Key pinch	Pad of thumb to medial aspect of index finger	12.3	9.1	8.6	6.4	DTI, 2000**+ (pg. 292) [Crosby et al., 1994]	
	Pulp pinch pull		4.6	3.2	3.2	2.3	DTI, 2000** (pg. 293) Imrhan, 1992 (paper)	
	Chuck pinch pull		6.7	4.7	4.7	3.3		
	Key pinch pull		10.1	7.1	7.1	4.9		
	Power grip		40.0	22.8	28.0	16.0	Mathiowetz et al., 1985	
	Thumb push	Forwards (elbow @ 90 degrees)	8.3	6.5	5.8	4.6	DTI, 2000** (pg. 270) [Schoorlemmer & Kanis 1992]	
		Downwards (free posture)	8.8	7.0	6.2	4.9		
	Trigger force	Triggering with use of one finger	2.0	1.4	1.4	1.0	Lee and Cheng, 1995 (pg.177)	
		Triggering with use of two fingers	4.0	2.8	2.8	2.0	Lee and Cheng, 1995 (pg.177)	
Whole Body	One hand push	Horizontal, walking	16.0	11.0	11.0	7.5	Mital, 1997 (pg. 77)	
	One hand pull	Horizontal, walking	15.0	10.0	10.0	7.0	Mital, 1997 (pg. 83)	
	One hand lift	Standing	9.0	6.0	6.3	4.2	Mital, 1997 (pg. 71)	
	One hand lift	Seated	8.0	5.6	5.6	3.9	Mital, 1997 (pg. 71)	
	Two person lift		54.0	40.0	37.8	28.0	Mital, 1997 (pg. 71)	

* Values from Eastman Kodak (1986) and DTI (2000) are converted from Newtons to kg of force.

+ Values from DTI (200) have been extrapolated to reflect 75% of population - similar to Snook table limits.

Note: Shaded areas are extrapolated using the following parameters:

1. Female Maximal Exertion = 70% of Male Maximal Exertion
2. Repetitive Use = 70% of Maximal Exertion

These parameters were determined using recommendations from Mital (1997) that maximum weights for females should never exceed 75% of male maximums while highly recommending not to exceed 2/3 of the maximum male values (pg. 119) and although many studies have found that a simple adjustment factor for repetition is not sufficient, a 30% reduction from maximal values may occur when increasing lifting frequency from once per minute to 12 times per minute (pg. 38).