

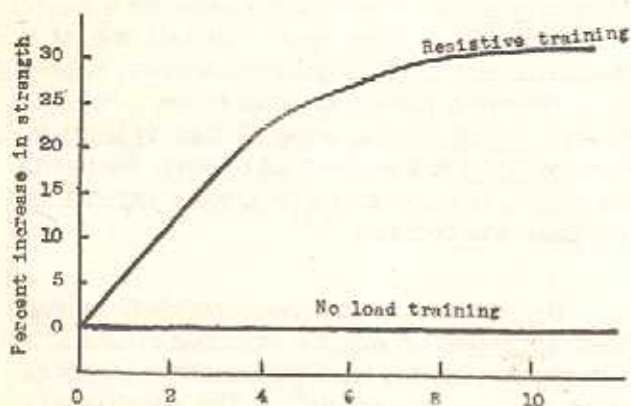
Whole body/part body conditioning

Isometric muscular contraction with hand gripping results in rise in arterial pressure by approximately 20 - 24 mm Hg². Another study determined that tensing of the abdominal muscles alone raises the blood pressure¹⁸. It was also determined that abdominal and thigh muscle conditioning was better than back and arm muscles¹¹. Presently, the consensus of opinion is that total body muscle strength is more beneficial than only part body conditioning^{1,13}.

The training programme should also pay due regard to the muscles of the neck. This is necessary since increase in pressure by the head and helmet during High-G loads greatly affects the neck and cervical spinal column structures. A number of surveys have reported neck injuries with increasing frequency during high G exposure^{1,13}.

Characteristic Of Resistive Training

One of the principles of muscle development is that the muscles which contract at or near their maximal force of contraction will develop strength very rapidly even if the contractions are performed only a few times each day¹⁶. Utilizing this principle optimal gains in strength can be achieved by the performance of resistive training on 3-4 days/week. It has been seen that there is as much as 30% gain in the



Approximate effect of optimal resistive exercise training on increase in muscle strength over a training period of 10 weeks.

Fig 1

strength during the first 6-8 weeks, thereafter a sort of plateau phase is reached (Fig 1)¹⁶.

Various investigations in physical training indicate that isokinetic training is most effective for the improvement in muscle strength as compared to training systems based purely on isotonic or isometric contractions^{13,19}. An isokinetic muscular contraction can be defined as a muscle contraction under constant velocity which can be fast or slow¹³. In simpler terms, isokinetic exercises are those in which muscles are pitted against a constant movable resistance eg., multigym equipment¹⁹.

Aerobic Fitness

Excessive Aerobic Fitness vis-a-vis Gz tolerance has been proved to be detrimental for a variety of reasons^{1,3,7&12-14}. However, the benefits of aerobics cannot be denied to the aviator. Not only is it a documented fact that longevity is increased^{11,19}, but aerobic conditioning also improves the overall physical and psychological fitness of the individual^{11,12,19}.

A programme of running (not more than 20 miles/week), has been seen to have no detrimental effect on Gz tolerance^{1,12}. Further, training should be such so that it does not lower the heart rate below 55 bpm⁷. Others have suggested a certain target heart rate range to be achieved, and thereafter to be maintained for 20 - 30 minutes. This range can be calculated as 60 - 80% of the maximal HR for that age ($220 - \text{age}$)¹. Aviators should also be encouraged to take part in sporting games especially those which stimulate a quick muscular reaction time eg. squash and tennis¹³. In essence, moderate levels of aerobic fitness are recommended.

Recommended Resistance Conditioning Programme

Before undertaking this, a few aspects need understanding and clarification.

1. **Exercise Specificity** : For optimal improvement, the programme must focus on the respiratory and skeletal muscle movements that are similar to the straining and tensing manoeuvres required to resist effects of High-G forces. To

simulate an AGSM, a full breath should be taken before the lifting phase. As the weight is being raised, straining should continue against a partially closed glottis¹.

2. Exercise Intensity : For maximal benefits in strength, the load should be 80 - 90% of the maximum weight that can be lifted on one occasion. This is called 1-RM or one repetition maximum. In a single set of exercise, the number of repetitions performed constitutes the RM load eg., if the 1-RM load for arm curls is determined to be 36 kg or 80 lbs, then 10 repetitions of curling 36 kg would constitute one set of 10 RM¹.

3. Determination of Intensity : This is done by trial and error and is totally subjective. Rough estimates for a starting RM load are as follows :

Table I Determination of starting RM-load

No	Exercise	RM-Load % Body Weight
1	Arm curls	40%
2	Bent rowing	60%
3	Bench press	80%
4	Arm pull down	75%
5	Upright rowing	50%
6	Leg press	100% + 10 lbs

If the desired number of repetitions is performed easily, then the RM load is too low and has to be increased. Further during the training phase, gains in strength will occur and hence RM loads need constant revision.

4. Exercise order : Muscle groups most useful in the performance of the AGSM need to be exercised first.

5. Warm-up and Cool-down : is extremely important. 5 - 10 minutes before and after every workout consisting of stretching exercises should be performed, as stiff muscles and joints are prone to injury.

6. Rest periods : Specific rest periods as indicated should be adhered to between sets and between exercises.

The actual conditioning programme is divided into two groups.

Table-II 12 Week Physical Conditioning/Strength Conditioning Workout

No.	Exercise	Sets	Repetitions/Sets
1	Leg Press	4	5
2	Bench Press	4	5
3	Lat. Pull	3	5
4	Military Press	3	8
5	Arm Curl	3	6
6	Sit-up (Leg raise)	2	10
7	Neck Series	3	6

* - Exercise listed in order of workout.
 ** - For 5-week programme 2 sets of each exercise only.

Warm-up : 5-10 min.
 Cool-down : 5-10 min.
 Rest Period : 2 min between sets.

a) **Strength Conditioning :** Herein sets of various exercises will range from 2 - 5. Table II, lists the exercises to be done in order of priority¹.

b) **Endurance Resistance Training :** This is characterised by paired exercises i.e., super sets are done. A super set is one in which, a set of the first exercise is performed and without a rest period another set of a second exercise is carried out. 2-3 supersets per exercise pair are performed. Table III lists the programme¹.

Table-III 12-Week Physical Conditioning Endurance Emphasis Workout

No	Exercise	Supersets	Repetition/set
1	Leg Extension	3	10
	Leg Curl		10
2	Bench Press	3	10
	Shoulder Shrug		10
3	Lat. Pull	3	10
	Seated Row		10
4	Military Press	3	10
	Upright Row		10
5	Tricep Extension	3	10
	Arm Curl		10
6	Sit Up	2	10
	Leg Raise		10
7	Neck Series	3	12

* - Exercise pairs listed in order of workout.
 ** - For 5-week programme 2 supersets only.

Warm-up : 5-10 min.
 Cool-down : 5-10 min.
 Rest Period : 2 min between supersets.

Studies have recommended that a 3-4 day/week resistance training programme is beneficial^{1,11,13}. A minimum of 24 hours should elapse between exercise sessions.

A typical programme is seen in Table - IV :-

Table-IV Weekly Programme

No	Exercise	Conditioning Requirement
1	Monday	Strength conditioning
2	Tuesday	Endurance Resistance
3	Wednesday	Running/Games
4	Thursday	Strength conditioning
5	Friday	Endurance Resistance
6	Saturday	Running/Games
7	Sunday	Running/Games

Ideally a 12 week conditioning programme is recommended^{1,11,13}. However, it is possible to shorten the time required to 5 weeks to accomplish gains in strength and endurance¹. For the short version of the programme, the exercise order is different from that of the long version and only 2 sets are performed of all the exercises.

At the Squadron Level

For most aviators, a 12 week lay-off from the routine for physical conditioning alone is not possible due to various reasons. Programme interruptions in the way of temporary duties, leave periods, training requirements, aircraft ferries etc are factors which need to be considered.

For the few who have been able to manage a 12 week schedule, a maintenance programme of 2-3 strength workouts per week is advocated. The workouts should not be performed on consecutive days. Aerobic fitness should be maintained at moderate levels¹.

For the un-initiated, the following guidelines apply. To begin with, a minimum of 5 weeks un-interrupted schedule should be arranged. In this time, sufficient training will have occurred to initiate gains in muscular strength and endurance^{1,16}. Subsequently during training interruptions, the individuals should continue the programme by whatever means possible. If standard exercise equipment is not available, the aviator should resort to exercises such as sit-ups, leg-raises, chair

presses, back arches, neck flexion, and extension and isometric contractions of major muscle groups¹.

If there has been a period of inactivity, resumption of the programme should be made as soon as possible. Benefits gained can be lost rapidly due to inactivity. After a 2 week or more layover, exercises should be resumed at a RM load of 80% of the load that was utilised before the interruption¹.

Conclusion

To take full advantage of the physical conditioning programme, the requirement of adequate preparation is a must. Like athletes, aircrew should warm up before maximum exertion. Ideally warm-up and stretching should begin 30 min before G exposure and taper to 5 min before the actual engagement. Also the aircrew should perform several moderately intense AGSM and several maximal neck stretches (1). These techniques recommended not only reduce the risk of injury but serve to enhance flying performance and combat capability of the pilot.

Physical conditioning has been determined to be a cost-effective measure for enhancement of a pilot's Gz tolerance. Not only can the aviator perform the AGSM more effectively, but he can do so with much less relative effort, and for longer periods under G-loading.

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