REVIEW OF LITERATURE
The problem of the relation between physical and mental development has an interesting history. The studies go back at least to Quetelet, who from 1835 to 1871 emphasized the importance of measurement of human qualities. His "Anthropometrie" published in 1871, made a profound and wide spread impression. It was undoubtedly Bowditch's work (1877) on growth of Boston School children, that led Tarbell to weigh and measure (for stature) all the children in his institution for feeble-minded children at Boston. Tarbell reported his results in 1881 at Frankfurt in the meeting of an organization of officers of institutions for feeble-minded. The results were published in 1883. He compared his data with those of Bowditch (1877) as a standard and published a diagram of comparative growth curves. Tarbell (1883) reached the following results in his study:

(i) throughout the period of growth the idiotic and feeble-minded children are about two inches shorter and nine pounds lighter than the normal children;

(ii) the relative rate of growth of the two sexes of idiot children corresponds very closely to that of the two sexes of normal children and is subject to the same variation at the age of puberty;
iii) the period of puberty is about two years later in idiots than in the normal children. Again in the Final Report of the Anthropometric Committee of the British Association issued in 1882, it appears that of all the various classes of community investigated, imbeciles are both the smallest and lightest in weight (TredGold 1956).

In 1886, Shuttleworth gathered together the heights and weights of both male and female idiots and imbeciles and reported that they are definitely shorter and lighter than their peers. Thus, his results also supported Tarbell’s findings (1883). The data of height and weight of general population used by Shuttleworth (1886) for comparison, was furnished by Charles Robert, the leading Anthropometrist of his day. Shuttleworth, in his paper, suggested that it would be better to compare institutionalized children with normal children from the same socio-economic class.

In 1893, Porter, in his paper, showed that precocious children are heavier, taller and have larger chestgirths and wider heads than dull children. The similar conclusions were reached by the two Russian observers i.e. Gratsianoff (1889) and Sack (1893). Gratsianoff (1889) found that successful pupils are larger and grow faster than unsuccessful ones and Sack (1892) concluded, after measuring 4245 boys, that the more successful children are taller and had larger chests than
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Differences between N-MR and M0W00S

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unsuccessful. Christopher (1900) found that 12-year-old children (scattered through the various grades, from I to VII) of the 1st grade averaged as low as 1300 mm in stature while those of VII grade had average stature above 1450 mm.

The results of Porter (1893) and Christopher (1900) were challenged by the work of Gilbert (1894), who apparently using the judgement of teachers as a basis of mental ability, stated that he could find no relation between height and mental ability. But it does not appear that he investigated this matter critically enough to warrant a definite conclusion. Again in 1897, Gilbert expressed the same opinion that there is no relation between weight and height and mental ability. West (1898) found the "poor" students "more fully developed" than "good" ones. Wissler (1901) found no correlation between 'success in class work' and grip; r is - 0.08. But Carman (1899), Smedley (1900) and Schuyten (1902) found a positive correlation between strength of grip and intelligence and this result was confirmed repeatedly.

Wylie (1899, 1903) discovered the greater variability in physical dimensions of defectives as compared with normal children. Wylie (1899) concluded from measurements of height and weight of 161 feeble-minded boys and 174 girls that feeble-minded children are subnormal in height and weight and also
that development is delayed among the feeble-minded. He also concluded that feeble-minded girls depart less from the normal than feeble-minded boys. Wylie (1903) returned to this subject some years later; after having measured more-feeble-minded children, he reached the same conclusions as before "the feeble-minded are subnormal in height and weight". The average of the feeble minded approximates the minimum of the normal and maximum of the feeble-minded approximates the average of the normals*. 

Norsworthy (1907) and Mead (1914, 1916) emphasized the correlation between degree of mental defect and inferiority in physical development. Goddard (1912), in an interesting paper on this question, found that not only do aments as a class compare very unfavourably in these respects with the normal population, but that the greater the degree of defect, the more marked is the discrepancy.

Whipple (1914) gives thoughtful interpretation of the relation between mental and physical development. "Thus to take the correlation in question, a positive correlation is not, of course, to be interpreted as meaning that taken individually, all tall boys are bright boys but that taken collectively, those boys whose physical condition is good, whose growth is unimpaired by ill-health, faulty nutrition, etc., and who realize to the full possibility of physical development
inherent in them (whether they are ultimately short or tall) will be found to exhibit the best mental condition and the most rapid mental development”.

Further support for Porter’s findings may be derived from the results of Arnold (1916), who concluded that the heavier the child for his age the higher is his school grade.

Doll (1916) made careful measurements of stature, sitting height, weight, grip and vital capacity of a fair number of feeble-minded boys and girls of various mental ages, 1 to 10 years. Doll considered his measurements in relation to Smeldley’s norms (1900), which was not very fortunate as these norms were for heterogeneous racial constitution of children. Doll concluded:

(i) there is a high correlation (0.30) between mental age and stature;
(ii) the feeble-minded not only grow at a retarded rate but also cease growing at an earlier age (thus refuting the theory (at least for feeble-minded) affirmed by some authors that children who grow at retarded rate continue growing for a longer period);
(iii) the feeble-minded are below normal in sitting height (which is highly correlated with stature);
(iv) the averages in weight for (feeble-minded) boys are below normal at all mental ages but those for girls are above normal
after mental-age 5. Their weight is closer to normal than either standing/sitting height or grip;

(v) correlation of right hand grip with mental age is nearly 0.70. Left grip is even more highly correlated.

In 1921, Naccarati compared intellectual development not only with one physical dimension like height and weight but a morphological index which was assumed to give a picture of the entire physical development. His subjects were college students. His morphologic index is the ratio of length of limb to volume of the trunk. He found a correlation between intelligence and morphological index of 0.356; between volume of trunk and intelligence of 0.36. However, others using Naccarati's method (Gates 1924, Sheldon 1927) found much smaller positive correlation, while Heidbreder (1926) found no correlation at all. Garrett and Kellogg (1928) also got very small correlation.

Baldwin (1922) obtained very high correlation between height and mental age (0.89); weight and mental age (0.71) and area of carpal bones and mental age (0.83).

Severson (1922) collected data on I.Q and roentgenographs of carpal development and found a correlation between the two of the order of 0.31 ± 0.06.

Carter and Freeman (1924) in high grade school children
found the correlation between carpal age and mental age to be practically zero.

Murdock and Sullivan's (1923) experiment with 600 pupils showed correlations between weight and intelligence (boys $0.16 \pm 0.4$, girls $0.13 \pm 0.04$) and between head size & intelligence (boys $0.20 \pm 0.04$, girls $0.27 \pm 0.03$).

Lutz (1924) confirmed the correlation between weight, stature and intellectual supremacy in school children. He also concluded that in intellectually superior children, puberty begins two years earlier than dull ones. Talbot (1924) reported a study of growth of 'untreated' mongolian idiots. His findings showed that mongolian idiots tend to be shorter than normals; they seem to have greater length of trunk than the normals; the circumference of head is reduced as compared to the normals; circumference of the chest was below normals in majority of the cases; greatest deviations were found in the measurement of extremities; length of arms and legs and foot being shorter than in the normals.

Johnson (1925) finds no tendency for mental age to increase with increasing weight at given heights. The correlation he found was only $0.04 \pm 0.05$. Abernethy (1936) reached about the same conclusions as Johnson.

Heaton (1925) studied the physical development of
children of high and low mental ability. For physical ratings he used height, weight, 75 yard dash, chest expansion, "push up" from floor and running broad jump. He concluded that the difference in the output of the two groups—'high and low mental ability' was greater in the case of boys than of girls, boys being slightly superior in height and markedly so in weight and clearly so in each of the performance groups.

Heidbreder (1926) found that height/weight ratio and percentile mental scores are correlated as $-0.01 \pm 0.03$, which means no correlation.

Cozen (1927), Bagley (1901) and Landis, Burtt and Nichols (1923) found no correlation between motor ability and mental output among children.

Cattell (1928) gave the coefficient of correlation between mental age and anthropometric data which varies in different age groups from $-0.03$ and $0.31$ with probable errors of $0.06$ to $0.09$. She also found out the correlation between mental age and anatomic index.

Wheeler (1929) like Cattell (1928) concluded that in all physical measurements (except trunk height/length and iliac width in girls) dull children are definitely below the normals. The result was accounted for by the other fact that dull children are retarded in developmental stage and mature late in chronological life.
In 1930, Davenport and Minogue made repeated measurements on 78 boys at an institution of feeble minded, for six years, to find the correlation between physical and mental development. In this investigation, correlations between physical age and mental age are found to vary from 0.24 to 0.48; and between the physical quotient and intelligence quotient from 0.29 to 0.49. Correlation between physical and mental development is about the same as that between the stature of brothers (about 0.50). It was also concluded that I.Q. of the feeble-minded boys tends to decrease slightly with age, probably more at first than later.

Abernethy (1936) studied the relationship between mental and physical growth and concluded that in normals the correlation between the two is slight and attributed this to the relative homogeneity of the normal population studied.

In one of the best studies in growth of mentally retarded, Flory (1936) used the concept of I.Q. to quantify intelligence and roengenograph to evaluate developmental age. Flory concluded that retardates grow at a slower rate but for a longer period of time. He found as did Goddard (1912) that within his sample the more intelligent subjects were larger and developmentally closer to their chronological ages. Flory (1936) also examined additional variables which may be related to mental and physical development, including family size,
birth order, parental age, conditions at delivery (illegitimacy) and socio-economic class. He also looked into the effect of institutionalization on growth.

Penrose (1949) strongly supported the etiologic approach to study mentally defectives and since then many studies were designed to evaluate physical characteristics of mentally retarded individuals grouped on the basis of various diagnostic or etiological categories.

Dutton (1959) studied two aspects of physical development of mongol boys i.e., height and skeletal maturation. It was shown that skeletal maturation is normal in 80 per cent of cases and that mongols, although deficient in linear growth, mature normally towards adulthood. Jones and Wales (1958) studied the heights and weights of educationally subnormal children. The height or weight indices which, resemble numerically the intelligence quotients were used for ready comparison with those of the normal children. 73 per cent of the retarded children had weight and height indices below the normal. No significant differences were observed between the measurements of boys and girls.

Dutton (1959a) and van Gelderen (1962) studied growth patterns in respect to the diagnostic groups, which led these authors to conclude that certain diagnostic groups of mentally
defective individuals have normal or nearly normal linear growth. In Dutton's study there were "Organic and non-pathological" "undifferentiated" categories while vanGelderen divided his sample of 384 children into six diagnostic groups based upon the time the alleged insult responsible for retardation took place. He suggested that the time of insult was critical to the differential growth of the six groups.

Growth changes in the mongoloid head were studied by Roche, Seward and Sunderland in 1961. The sample consisted of 67 male and 81 female white Australian mongoloids. Maximum head breadth was within the normal range (+2 S.D.) for the first year of life. In comparison with normal children, the increase was then less rapid until the age of five years, more rapid until the age of nine years, after which no continuing increase was observed. In the female group, the changes were similar. During first few months of life the maximum head length was almost normal. It then increased much more slowly than in normal children until about the age of five years after which both groups showed equal rates of increase. Most mongoloids were found to be brachycephalic or hyperbrachycephalic, but examples of mesocephaly and dolichocephaly were also observed.

Rundle and Sylvester (1962), Culley Jolly and Mertz (1963) supported the earlier findings that mental defect
correlates with impaired physical growth. The same was noted by Tanner (1961, 1962), Watson and Lowrey (1962).

In 1961 and 1965, Mosier, Grossman and Dingman studied the physical growth of institutionalized mentally defectives. They concluded that the degree of impairment in growth is related to I.Q. deficit. Their conclusion is based on the anthropometric measurements of 2027 mentally defectives classified under five diagnostic headings. No differences between diagnostic categories were noted with the exception of mongolism in which stunting was greater than in other categories (shortening of the lower extremity accounted for this difference). Another conclusion reached was that the secondary sex development with increase of degrees of mental deficiency occurs correspondingly later. Mongoloid patients showed greater variance in the time of onset of secondary sex manifestations than did diagnostic groups. Critically viewing this growth study of mentally retarded children, Marshall (1968) points out that these diagnostic divisions of mentally retarded have little meaning in terms of pathology and, with the exception of mongols, none of these groups can be regarded other than as a sample of mental defectives of mixed aetiology. He further states "Also as these authors point out, the patients with the lowest I.Qs were the least co-operative and were probably measured least accurately. The measurements would tend to be too low.
rather than too high and this bias might easily produce a spurious negative correlation between IQ and stature."

Thelander and Pryor (1966) studied the abnormal patterns of Growth and development in Mongolism (the sample consisted of 146 mongolian children). Their study has shown (i) mongols are consistently below normal range for standing height at all ages and become relatively shorter each year to 15 years of age (ii) their heads are small and cease to grow after 2½ to 3 years of age. There is a greater deficit in cephalic length and caphalic breadth (iii) ear length is dwarfed at every age. Vestigial ears are practically universal (iv) dimensions of face lay in both height and width. The mongols retain their round faces (v) trunk diameters and sitting height are closer to the normal range for each age of both sexes (vi) width-length indices of body build classify them all as "stocky" (vii) boys are more variable than girls in all the measurements.

Pozsonzi and Lobb (1967) studied the physical growth in 799 educationally subnormal children and concluded in general that "physical growth is not necessarily related to subnormal mental functioning".

In 1967, Bailit and Whelan carried out an investigation on a diagnostically discrete group of mentally retarded individuals (77; 6 to 25 years of age). The sample was studied
anthropometrically and information was obtained regarding birth weight, parental age at birth, birth order, IQ and age at admission. The sample subjects were found to be retarded for all 11 measurements when compared to published standards of Caucasian Philadelphia children. Height, head length, bia-cromial and bi-iliac diameters were most reduced; approximately 25 to 40 per cent of the subjects were two or more standard deviations below the normal population mean for these dimensions. Compared to studies of children with Down's syndrome, the familial retardates were found to be considerably taller.

Donoghue and Abbas (1972) studied the physical condition of 293 severely subnormal children in Hospital. It was observed that exactly 50% of the measured patients were below lower limit of both height and weight of normal children of the same age and sex.