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**2020-2021  
FACULTY RESEARCH  
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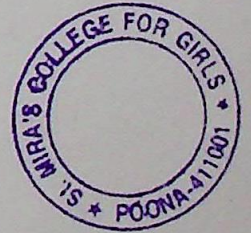


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Sr. No.	Year	Department	Name of Faculty	Title of Paper	Name of Journal	ISSN	UGC Listing No/Link
1	2020	Mathematics	Deepa Krishnamurthi	Matrices over non-commutative rings as sums of powers pp.1-5	Linear and Multilinear Algebra, Vol. 68, 2020 April	0308-1087	Scopus <a href="https://doi.org/10.1080/03081087.2020.1748856">https://doi.org/10.1080/03081087.2020.1748856</a>
2	2020	Commerce	Rajni Singh	A Study of Customers' Perception of Efficiency and Effectiveness of Waiting Line Management in Private Hospitals in Pune City pp.58-63	Juni Khyat (UGC Care Group I Listed Journal) Vol-10 Issue-6 No. 6 June 2020	2278-4632	<a href="https://ugccae.unipune.ac.in/Apps/1_ser/Web/ViewDetails?JournalId=101002783&amp;lag=Search">https://ugccae.unipune.ac.in/Apps/1_ser/Web/ViewDetails?JournalId=101002783&amp;lag=Search</a>
3	2020	Commerce	Rajni Singh	A Comparative Study of Internal Marketing Strategies in Euro International School and Dastur Public School in Pune City pp. 183-191	Juni Khyat (UGC Care Group I Listed Journal) Vol-10 Issue-6 No. 6 June 2020	2278-4632	<a href="https://ugccae.unipune.ac.in/Apps/1_ser/Web/ViewDetails?JournalId=101002783&amp;lag=Search">https://ugccae.unipune.ac.in/Apps/1_ser/Web/ViewDetails?JournalId=101002783&amp;lag=Search</a>
4	2020	Psychology	Jaya Rajagopalan	Attitudinal and Perceptual Dimensions of Body Image in Adolescents. pp.142-163	JACAM ,October 2020 (Volume 16, Issue 4)	0973-1342	<a href="https://www.scimagojr.com/journalsearch.php?q=470015243&amp;tip=sid">https://www.scimagojr.com/journalsearch.php?q=470015243&amp;tip=sid</a>

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## Matrices over non-commutative rings as sums of powers

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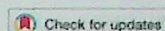
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# Matrices over non-commutative rings as sums of powers

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## ABSTRACT

Let  $R$  be non-commutative ring with unity and  $n \geq p \geq 2$ ,  $p$  prime. In this paper, we prove that an  $n \times n$  matrix over  $R$  is the sum of  $p$ th powers if and only if its trace can be written as a sum of  $p$ th powers and commutators modulo  $pR$ . This extends the results of L. N. Vaserstein ( $p = 2$ ) and S. A. Katre, Kshipra Wadikar ( $p = 3$ ). We also obtain necessary and sufficient conditions for a matrix over  $R$  to be written as a sum of fourth powers when  $n \geq 2$ .

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## 1. Introduction

Carlitz showed as a solution to a problem proposed in Canadian Mathematical Bulletin that every  $2 \times 2$  integer matrix is a sum of at most 3 squares (see [1]). Initial work related to integer matrices and matrices over commutative rings as sums of squares can be found in [2, 3]. Wadikar and Katre [4] proved that every integer matrix is a sum of four cubes. Richman [5] studied Waring's problem for matrices over commutative rings as sums of  $k$ th powers. Katre and Garge [6] gave generalized trace condition for a matrix over a commutative ring to be a sum of  $k$ th powers.

All our rings are associative. By a non-commutative ring, we mean a ring with unity which is not necessarily commutative. In this paper,  $R$  will be a non-commutative ring, and  $M_n(R)$  will denote the ring of  $n \times n$  matrices over  $R$ . For a non-commutative ring  $R$ , Vaserstein proved that a matrix of size  $n \geq 2$  over  $R$  is a sum of squares if and only if its trace is a sum of squares modulo  $2R$  (see [7]). Recently, Katre and Wadikar proved that a matrix of size  $n \geq 2$  over  $R$  is a sum of cubes if and only if its trace is a sum of cubes and commutators modulo  $3R$  (see [8]). In this paper, in the context of Waring's problem for matrices, we obtain such a result for  $p$ th powers when  $n \geq p \geq 2$ ,  $p$  prime. We also obtain an analogue of this result for fourth powers for  $n \geq 2$ . For both these results, we use the

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following general trace condition for a matrix over a non-commutative ring to be a sum of  $k$ th powers ([8], Theorem 3.2).

**Theorem A (Katre, Wadikar):** Let  $n, k \geq 2$  be integers and  $A \in M_n(R)$ .  $A$  is a sum of  $k$ th powers of matrices in  $M_n(R)$  if and only if  $\text{trace}(A)$  is a sum of traces of  $k$ th powers of matrices in  $M_n(R)$ .

**Notations:**  $E_{ij}$ : The  $n \times n$  matrix whose  $(i, j)$ th entry is 1 and other entries are 0.  $E'_{ij}$ : The  $p \times p$  matrix whose  $(i, j)$ th entry is 1 and other entries are 0.  $C(a_1, a_2, \dots, a_k) = a_1 a_2 \cdots a_k + a_2 a_3 \cdots a_k a_1 + \cdots + a_k a_1 a_2 \cdots a_{k-1}$ , where  $a_1, a_2, \dots, a_k \in R$ , is called a cyclic sum of length  $k$ .  $[x, y] = xy - yx$  is called the commutator of  $x$  and  $y$ . Note that  $-C(a_1, a_2, \dots, a_k) = C(-a_1, a_2, \dots, a_k)$  is a cyclic sum and  $-[x, y] = [-x, y]$  commutator.

## 2. Matrices as sums of $p$ th powers

**Proposition 2.1:** For  $a_1, a_2, \dots, a_k \in R$ , the cyclic sum  $C(a_1, a_2, \dots, a_k)$  is a sum of commutators modulo  $kR$ .

**Proof:** Observe that  $a_1 a_2 \cdots a_k + a_2 a_3 \cdots a_k a_1 + \cdots + a_k a_1 a_2 a_3 \cdots a_{k-1} = (a_2 a_3 \cdots a_k) a_1 - a_1 (a_2 a_3 \cdots a_k) + (a_3 a_4 \cdots a_k)(a_1 a_2) - (a_1 a_2)(a_3 a_4 \cdots a_k) + \cdots + a_k (a_1 a_2 \cdots a_{k-1}) - (a_1 a_2 \cdots a_{k-1}) a_k + k a_1 a_2 \cdots a_k = [a_2 a_3 \cdots a_k, a_1] + [a_3 a_4 \cdots a_k, a_1 a_2] + \cdots + [a_k, a_1 a_2 \cdots a_{k-1}] + k a_1 a_2 \cdots a_k$ .

We also consider the action of the cyclic group generated by  $\sigma = (1, 2, \dots, k) \in S_k$ , the permutation group on  $k$  symbols, on the set of  $k$ -tuples of elements of a set. This action is defined by  $\sigma(a_1, a_2, \dots, a_k) = (a_2, a_3, \dots, a_k, a_1)$ . If  $k = p$  is a prime, then, since the number of elements in the orbit of any  $p$ -tuple divides  $p =$  order of the group  $\langle \sigma \rangle$ , the orbit has 1 or  $p$  elements. Hence if at least two of  $a_1, a_2, \dots, a_p$  are unequal, the orbit has exactly  $p$  elements. ■

**Proposition 2.2:** If  $R$  is a non-commutative ring and  $n \geq p \geq 2$ ,  $p$  prime, then for  $A \in M_n(R)$ ,  $\text{trace}(A^p)$  is the sum of  $p$ th powers of diagonal elements of  $A$  and cyclic sums  $C(a_1, a_2, \dots, a_p)$  with  $a_1, a_2, \dots, a_p \in R$ .

**Proof:** If  $A = (a_{ij})$ , then  $\text{trace}(A^p) = \sum_{1 \leq j_1 \leq j_2 \leq \dots \leq j_p \leq n} a_{j_1 j_2} a_{j_2 j_3} \cdots a_{j_p j_1} = \sum_{i=1}^n a_{ii}^p + \sum_{(j_1, j_2, \dots, j_p) \in B} a_{j_1 j_2} a_{j_2 j_3} \cdots a_{j_p j_1}$  where  $B$  is the set of all  $(j_1, j_2, \dots, j_p)$  for which at least two of  $j_1, j_2, \dots, j_p$  are unequal. Since  $p$  is a prime, for  $(j_1, j_2, \dots, j_p) \in B$ , the orbit of  $(j_1, j_2, \dots, j_p)$  under the cyclic change, i.e. the action of the cycle  $\sigma = (1, 2, \dots, p) \in S_p$ , has  $p$  elements. Thus, there are  $p$  distinct  $p$ -tuples obtained from cyclic changes in  $(j_1, j_2, \dots, j_p)$ , and they together give rise to  $C(a_{j_1 j_2}, a_{j_2 j_3}, \dots, a_{j_p j_1})$ . All such cyclic sums corresponding to different orbits give rise to the second sum. ■

**Theorem 1:** Let  $n \geq p \geq 2$ ,  $p$  prime, be integers. Let  $T_p = T_{p,n}$  be the set of those elements of  $R$  that can be expressed as sums of traces of  $p$ th powers of  $n \times n$  matrices over  $R$ .

(i) For  $a, a_1, a_2, \dots, a_p \in R$ , the cyclic sum  $C(a_1, a_2, \dots, a_p) \in T_p$ . Also  $pa \in T_p, a^p \in T_p$ .



- (ii)  $T_p = \{ \sum_{(a_1, a_2, \dots, a_p) \in S} C(a_1, a_2, \dots, a_p) + \sum_{j=1}^l c_j^p \mid l \geq 1, S \text{ is a finite subset of } R^p, a_i, c_j \in R, 1 \leq i \leq p, 1 \leq j \leq l \}$ .
- (iii)  $T_p = \{ \sum_{(a_1, a_2, \dots, a_p) \in S} C(a_1, a_2, \dots, a_p) + c^p \mid S \text{ is a finite subset of } R^p, a_i, c \in R, 1 \leq i \leq p \}$ .
- (iv)  $T_p = \{ \sum_{j=1}^q (a_j b_j - b_j a_j) + \sum_{j=1}^l c_j^p + pr \mid a_j, b_j, c_j, r \in R, q \geq 1, l \geq 1 \}$ .
- (v)  $T_p = \{ \sum_{j=1}^q (a_j b_j - b_j a_j) + c^p + pr \mid a_j, b_j, c, r \in R, q \geq 1, l \geq 1 \}$ .
- (vi) A matrix  $A \in M_n(R)$  is a sum of  $p$ th powers if and only if  $\text{trace}(A)$  is a sum of  $p$ th powers and commutators modulo  $pR$  if and only if  $\text{trace}(A)$  is a sum of a  $p$ th power and commutators modulo  $pR$ .
- (vii) Vaserstein ([7], Theorem 1): A matrix  $A \in M_n(R)$  is a sum of squares if and only if  $\text{trace}(A)$  is a sum of squares modulo  $2R$ .

**Proof:** (i) Let  $E'_{ij}$  be the  $p \times p$  matrix as in Section 1 and  $O_{n-p}$  be the zero matrix of order  $n-p$ . Let  $F = a_1 E'_{12} + a_2 E'_{23} + \dots + a_{p-1} E'_{p-1,p} + a_p E'_{p,1}$ . Then, as in the proof of Proposition 2.2,  $C(a_1, a_2, \dots, a_p) = \text{trace}(F^p) = \text{trace}(F \oplus O_{n-p})^p$ . Hence  $C(a_1, a_2, \dots, a_p) \in T_p$ . As  $C(a, 1, 1, \dots, 1) = pa$ , we get  $pa \in T_p$ . Also  $a^p = \text{trace}((aE_{11})^p) \in T_p$ ,  $E_{11}$  being as in Section 1.

- (ii) By (i), R.H.S. of (ii)  $\subseteq T_p$ . Conversely,  $T_p \subseteq$  R.H.S. of (ii) by Proposition 2.2.
- (iii) Let  $S$  be a set of representatives of orbits of  $p$ -tuples of elements of  $\{c_1, c_2, \dots, c_l\} \subseteq R$  and let  $S'$  be the set of such representatives in which we have at least two unequal entries. Then, the multinomial theorem for  $p$ th powers can be written as

$$\begin{aligned} (c_1 + c_2 + \dots + c_l)^p &= \sum_{(d_1, d_2, \dots, d_p) \in S} C(d_1, d_2, \dots, d_p) \\ &= \sum_{j=1}^l c_j^p + \sum_{(d_1, d_2, \dots, d_p) \in S'} C(d_1, d_2, \dots, d_p). \end{aligned} \tag{1}$$

Hence  $\sum_{j=1}^l c_j^p = (c_1 + c_2 + \dots + c_l)^p - \sum_{(d_1, d_2, \dots, d_p) \in S'} C(d_1, d_2, \dots, d_p)$ . Now,  $-C(d_1, d_2, \dots, d_p) = C(-d_1, d_2, \dots, d_p)$ . Thus,  $\sum_{j=1}^l c_j^p = (c_1 + c_2 + \dots + c_l)^p + \sum_{(d_1, d_2, \dots, d_p) \in S'} C(-d_1, d_2, \dots, d_p)$ . Hence using (ii), we get (iii).

- (iv) From (ii) and Proposition 2.1,  $T_p$  is a subset of the set of sums of commutators and  $p$ th powers modulo  $pR$ . Conversely,  $[a, b] = ab - ba = a \cdot \underbrace{1 \cdot 1 \cdot \dots \cdot 1}_{p-2} \cdot b + \underbrace{1 \cdot 1 \cdot \dots \cdot 1}_{p-2} \cdot b \cdot a + \underbrace{1 \cdot 1 \cdot \dots \cdot 1}_{p-3} \cdot b \cdot a \cdot 1 + \dots + b \cdot a \cdot \underbrace{1 \cdot 1 \cdot \dots \cdot 1}_{p-2} - p \cdot b \cdot a = C(a, 1, \dots, 1, b) \in T_p$  by (ii).
- (v) Now, using (iii) and Proposition 2.1,  $T_p \subseteq$  R.H.S of (v). By (iv), R.H.S. of (v)  $\subseteq T_p$ .
- (vi) This follows from Theorem A using (iv) and (v).
- (vii) We have  $[a, b] = ab - ba = (a + b)^2 + a^2 + b^2$  modulo  $2R$ . Hence by (iv)  $T_2 = \{ \sum_{j=1}^l c_j^2 + 2r \mid c_j, r \in R, l \geq 1 \}$ . So using (vi) for  $p = 2$  we get (vii). See also ([8], Theorem 3.9).

Note:  $T_p = T_{p,n}$  is independent of  $n$  for  $n \geq p \geq 2$ .



**Corollary 2.1 (Richman, [[5], Proposition 4.2]):** Let  $n \geq p \geq 2$ ,  $p$  prime and  $R$  be a commutative ring with unity.  $A \in M_n(R)$  is a sum of  $p$ th powers if and only if  $\text{trace}(A)$  is a  $p$ th power modulo  $pR$ .

**Proof:** Since  $R$  is a commutative ring with unity, every commutator is zero. Now use (vi) of Theorem 2.1.

In the case of  $p$ th powers, we required to show in our proof that a cyclic sum  $C(a_1, a_2, \dots, a_p)$  is in  $T_p$ . For this, we showed that  $C(a_1, a_2, \dots, a_p) = \text{trace}(F^p)$ , where  $F$  is a  $p \times p$  matrix. Because of this our proof required  $n \geq p$ . We shall see in the next section that for fourth powers we can make use of the four entries in a  $2 \times 2$  matrix to show that  $C(a, b, c, d) \in T_4$ . This will give us a criterion for  $A \in M_n(R)$  to be a sum of fourth powers for  $n \geq 2$ .  $\blacksquare$

### 3. Matrices as sums of fourth powers

The following theorem gives a non-commutative version of Theorem 6.3 in [6].

**Theorem 2:** Let  $n \geq 2$  be an integer and let  $T_4 = T_{4,n}$  be the set of those elements of  $R$  that can be expressed as sums of traces of fourth powers of  $n \times n$  matrices over  $R$ . For  $a, b, c, d \in R$ , let  $C(a, b, c, d) = abcd + bcda + cdab + dabc$  and  $D(a, b) = abab + baba$ . Then

- (i) For  $a, b, c, d \in R$ ,  $C(a, b, c, d) \in T_4$ . Also  $4a, a^4, 2a^2, [a, b], D(a, b) \in T_4$ .
- (ii)  $T_4 = \{ \sum_{j=1}^q C(a_j, b_j, c_j, d_j) + \sum_{j=1}^l D(e_j, f_j) + \sum_{j=1}^l g_j^4 | a_j, b_j, c_j, d_j, e_j, f_j, g_j \in R, q, l, l \geq 1 \}$ .
- (iii)  $T_4 = \{ \sum_{j=1}^q (a_j b_j - b_j a_j) + \sum_{j=1}^l c_j^4 + 2 \sum_{j=1}^l d_j^2 + 4r | a_j, b_j, c_j, d_j \in R, q, l, t \geq 1 \}$ .
- (iv) A matrix  $A \in M_n(R)$  is a sum of fourth powers if and only if  $\text{trace}(A)$  is a sum of fourth powers and  $2(\text{sum of squares})$  and commutators modulo  $4R$ .
- (v) A matrix  $A$  in  $M_n(R)$  is a sum of fourth powers if and only if  $\text{trace}(A) = x_0^4 + 2x_1^2 + 4x_2 + a$  sum of commutators where  $x_0, x_1, x_2 \in R$ .

**Proof:** (i) For the  $2 \times 2$  matrix  $E'_{ij}$ , and the zero matrix  $O_{n-2}$  of order  $n-2$ , let, for  $a, b, c, d \in R$ ,

$$N_1 = \begin{pmatrix} a & b \\ d & c \end{pmatrix}, \quad N_2 = \begin{pmatrix} a & -b \\ d & 0 \end{pmatrix}, \quad N_3 = \begin{pmatrix} 0 & -b \\ d & c \end{pmatrix},$$

$$N_4 = \begin{pmatrix} 0 & b \\ d & 0 \end{pmatrix}, \quad N_5 = \begin{pmatrix} 0 & a \\ a & 0 \end{pmatrix}, \quad N_6 = \begin{pmatrix} 0 & c \\ c & 0 \end{pmatrix}.$$

We have,  $\text{trace} \sum_{i=1}^4 N_i^4 = [a^4 + C(a, a, b, d) + C(b, c, c, d) + D(b, d) + C(a, b, c, d) + c^4] + [a^4 - C(a, a, b, d) + D(b, d)] + [-C(b, c, c, d) + D(b, d) + c^4] + D(b, d) = 2a^4 + 2c^4 + 4D(b, d) + C(a, b, c, d) = \text{trace} N_5^4 + \text{trace} N_6^4 + 4D(b, d) + C(a, b, c, d)$ . Hence  $C(a, b, c, d) = \text{trace} \sum_{i=1}^6 N_i^4$  modulo  $4R = \text{trace} \sum_{i=1}^6 (N_i \oplus O_{n-2})^4$  modulo  $4R$ , so  $C(a, b, c, d) \in T_4$ . Also  $C(a, 1, 1, 1) = 4a$ , hence  $4a \in T_4$ . For  $E_{11}$  as in Section 1,



$a^4 = \text{trace}(aE_{11})^4 \in T_4$ . Also

$$2a^2 = \text{trace}((E'_{12} + aE'_{21}) \oplus O_{n-2})^4 \in T_4.$$

Since  $[a, b] = a \cdot 1 \cdot 1 \cdot b + 1 \cdot 1 \cdot b \cdot a + 1 \cdot b \cdot a \cdot 1 + b \cdot 1 \cdot 1 \cdot a - 4ba$ , so  $[a, b] \in T_4$ . Also  $D(a, b) = [a, bab] + 2baba$ . Now  $[a, bab] \in T_4$  as it is a commutator and  $2baba = 2(ba)^2$  is in  $T_4$ . Hence  $D(a, b) \in T_4$ .

- (ii) From (i),  $C(a_j, b_j, c_j, d_j) \in T_4$ , also  $g_j^4 \in T_4$ . Thus, every element of R.H.S. of (ii)  $\in T_4$ . Conversely, for  $A \in M_n(R)$ , trace of  $A^4$  is sum of fourth powers of diagonal entries and entries of the type  $C(a, b, c, d)$  and  $D(e, f)$ , so  $T_4 \subseteq$  R.H.S of (ii).
- (iii) By (i),  $[a, b] \in T_4$ . Also by (i) every term in the elements of R.H.S. of (iii)  $\in T_4$ , so R.H.S. of (iii)  $\subseteq T_4$  and conversely by (ii)  $T_4 \subseteq$  R.H.S. of (iii).
- (iv) A matrix  $A \in M_n(R)$  is a sum of fourth powers if and only if trace of  $A$  is a sum of traces of fourth powers of matrices in  $M_n(R)$  if and only if, by (iii),  $\text{trace}(A)$  is a sum of fourth powers and  $2(\text{sum of squares})$  and commutators modulo  $4R$ .
- (v) By (iv),  $A$  in  $M_n(R)$  is sum of fourth powers if and only if  $\text{trace}(A)$  is a sum of fourth powers and  $2(\text{sum of squares})$  and sum of commutators modulo  $4R$ . Now consider  $a^4 + b^4 = (a + b)^4 - (a^3b + a^2ba + aba^2 + ba^3) - (ab^2a + b^2a^2 + ba^2b + a^2b^2) - (b^2ab + bab^2 + ab^3 + b^3a) - (baba + abab) = (a + b)^4 -$  cyclic sums  $-[b, aba] + 2(ab)^2$ . Since every cyclic sum is a sum of commutators modulo  $4R$ , we get  $a^4 + b^4 = (a + b)^4 + 2(ab)^2 +$  a sum of commutators modulo  $4R$ . Also  $a^2 + b^2 = (a + b)^2 + [a, b] + 2ba$ . Using this repeatedly, we get the result. ■

Note:  $T_4$  is independent of  $n$  for  $n \geq 2$ .

**Corollary 3.1 (Katre-Garge, [[6], Theorem 6.3]):** *If  $R$  is a commutative ring with unity, then  $A$  in  $M_n(R)$  is a sum of fourth powers if and only if  $\text{trace}(A) = x_0^4 + 2x_1^2 + 4x_2$  for some  $x_0, x_1, x_2 \in R$ .*

**Proof:** Since  $R$  is commutative, all commutators are zero, so the result follows from (v) of Theorem 2. ■

We note the following relation between  $\text{trace}(M^q)$  and  $\text{trace } M$ , for  $q$  prime.

**Proposition 3.1:** *Let  $R$  be a ring,  $q$  prime. For  $M \in M_n(R)$ ,  $\text{trace } M^q = (\text{trace } M)^q +$  a sum of commutators modulo  $qR$ .*

**Proof:** Let  $M = (a_{ij})$ , then  $\text{trace}(M^q) = \sum_{1 \leq j_1, j_2, \dots, j_q \leq n} a_{j_1 j_2} a_{j_2 j_3} \dots a_{j_q j_1}$ . If all the  $j_i$  are equal, we get a  $q$ th power and if at least two of  $j_1, j_2, \dots, j_q$  are unequal,  $q$  being a prime, there are  $q$  distinct  $q$ -tuples obtained from  $j_1, j_2, \dots, j_q$  by a cyclic change. Thus,  $\text{trace}(M^q) = a_{11}^q + a_{22}^q + \dots + a_{qq}^q +$  cyclic sums  $= (a_{11} + a_{22} + \dots + a_{qq})^q +$  a sum of commutators modulo  $qR$  by (1) and Proposition 2.1. Hence  $\text{trace}(M^q) = (\text{trace } M)^q +$  sum of commutators modulo  $qR$ . ■





**Lemma 3.1:** For  $\alpha \in R$  the following are equivalent:

- (i)  $\alpha$  is a sum of cubes and commutators modulo  $3R$ .
- (ii)  $\alpha$  is a sum of a cube and commutators modulo  $3R$ .

**Proof:** (ii) implies (i) is clear.

By Equation (1), for  $p = 3$ ,  $\sum_{j=1}^i c_j^3 = (\sum_{j=1}^i c_j)^3 - \sum_{(d_1, d_2, d_3) \in S^i} C(d_1, d_2, d_3)$ . Now  $-C(d_1, d_2, d_3) = C(-d_1, d_2, d_3)$ , hence the result follows from Proposition 2.1. ■

Using this, we get the following corollary.

**Corollary 3.2:** For  $n \geq 2$ , a matrix  $A$  in  $M_n(R)$  is a sum of cubes if and only if trace  $(A)$  is a sum of a cube and commutators modulo  $3R$ .


**Proof:** The proof follows from ([8], Theorem 3.13 (iv)) and Lemma 3.1. ■

**Remark 3.1:** The results in Theorem 2.1 and Corollary 2.1 are for  $n \times n$  matrices as sums of  $p$ th powers,  $p$  prime, when  $n \geq p \geq 2$ . The problem remains for  $p > n \geq 2$ , i.e. we expect to get the result for all  $n \geq 2$ . For  $p = 3$ , this is handled in [6] and [8] for the commutative and non-commutative set up, respectively, and for  $p = 5, 7$  it is done in [9] in the commutative set up. The problem is open for the remaining values of  $p$ .

### Disclosure statement

No potential conflict of interest was reported by the author(s).

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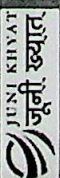
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## A Study on Impact of Technology on Service Delivery in Crowne Plaza Hotel Pune.

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**Abstract** - The research objective was focused on the impact of technology on service delivery that is used in 5 star hotels. The best usage of the upgraded technology that gives the staff to make their work easier. The link between the new technology and the service delivery work hand in hand, as it gives an impact on the customers as well as the hotels. Many hotels use variety of techniques and methods to keep their hotel updated with the latest technology and how well they are satisfied with the usage and friendliness towards the technology.

**Keywords** – technology, 5 star hotels, service delivery, customer satisfaction

**1.1 Introduction** - A study on impact of technology on service delivery in crowne plaza hotel. The variety of 5 star hotels in Pune are termed to provide the best impact of technology on the service delivery .Crowne plaza is known as one of the best 5 star hotels which believe in providing the best output to their customers as well as the staff. Using the best and updated technology gives them a better outlook. It comes under InterContinental Hostels Group (IHG); one of the leading companies has established Pune's first Crowne Plaza...

Crowne Plaza Pune has the best chefs from around the world and they prepare a tailored buffet for their customers. Crowne Plaza is well known for its location and professional meetings also for organizing parties for business and corporate events at large.

**1.2 Industry overview** – The best place to meet is Crowne Plaza and is also known as the best City Centre of Pune, You can plan a holiday or a business meeting at Crowne Plaza . The hotel is located in a location of 5 minutes drive from Pune Station & is a short 21-minute drive from Pune Airport. Travel easily to other parts of the city as you would take hardly few minutes to reach your destination and enjoy with readily available taxis, auto and bus stations in the area. Crowne Plaza is one of the well known hotels for stay or meetings and serves the customers in the best way.

**1.3 Statement of the problem** - The study attempts to find out the various technologies used in the hospitality industry that gives a greater impact on the service delivery of the hotels. The hotels efficiency and effectiveness by usage of the latest technology to reduce their work load and make the work easier for the employees as well as a safe and happy stay for the customers.

**1.4 Hypothesis** – $H_0$  According to the researcher hotel crowne plaza pune has the best impact of technology on service delivery.

$H_1$  The research stands negative as crowne plaza believes in manual work and does not use any kind of technology.



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### 1.5 Objectives -

1. To study the service delivery system used in the hotels
2. To study the technology used in the employee customer interaction
3. To understand the satisfaction from the technology interfaces
4. To study the employees skill and friendliness with the technology
5. To study the impact of technology on the firm's efficiency and effectiveness relating to service

**1.6 Significance of the study** - The impact of technology on service delivery system is going to help to find out how efficiently and effectively on the service delivery work hand in hand.

**1.7 Limitations** - The study is to be carried out in one outlet of crowne plaza pune. The research carried out should have relevant information about the topic and the data collected. It is always uncertain that the hotels will give permission to collect data from their employees. The data collected should be reliable to conduct a successful research; few unanswered or untruthful answers from the data collected would make the data invalid for the researcher.

The competition growing in the hospitality industry is vast. Every hotel wants to provide the best output to their customers and keep them updated with the latest technologies which help them to have a strong competition amongst other hospitality industries.

### 2.1 Theoretical background-

#### 2.1.1 Definitions:

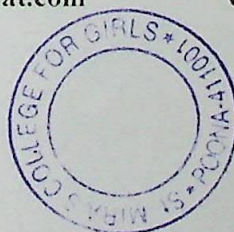
**Service marketing** - The American Marketing Association defines services as - "Activities, benefits and satisfactions which are offered for sale or are provided in connection with the sale of goods."

**Hotel** - A 5 Star Hotel is known to give the better services and is geared towards catering to their guests at the highest comfort level. Everything from the exterior to the interior has to be lavish and appealing & should display excellent quality and minute detailing.

**Technology**- Technology is defined as the methods, system & devices which give a greater impact as the result of scientific knowledge being used for practical purpose. Smart technology is the future of this era which will be used to improve efficiency & productivity.

**Service delivery**- A framework (SDF) is a set of principles, standards, policies and constraints to be used to guide the designs, development, deployment, operation and retirement of services delivered by a service provider with a view to offering a consistent service experience to a specific user community in a specific business context. The greatest challenge for any hospitality industry. Impact of technology on service delivery is a greater challenge for the hospitality industry.

**2.1.2 Challenges** - With today's competitive world every hospitality industry is growing to give



The best outputs to their customers and reduce the time and work for the employees. To upgrade They with the latest technologies are the greatest challenge for any hospitality industry. Impact of technology on service delivery is a greater challenge for the hospitality industry.

### 3.1 Review of literature -

#### 3.1.1 Technology, service quality, and customer loyalty in hotels: Australian managerial perspectives

Shan-Chun Lee, Sunita Barker, Jay Kandampully

*Managing Service Quality: An International Journal*, 2003

The objectives are to stay in the forefront of today's marketplace and to improve service, efficiency, and profitability. The hospitality industry is now more competitive and is mainly focused on serving their customers in such a way that they turn back to them next time, they should not prefer one hotel over the other due to their lack of their technology and services. The Hotel industry has transformed itself into global industry and is the best example of a hospitality industry. Various technological developments have their adoption in the hospitality industry and this has provided numerous opportunities and challenges due to growing competition between them. The customers expect improving service quality with every visit and inverse relationship the hotels expect customer loyalty.

#### 3.1.2 A study of hotel information technology applications

Rob Law, Giri Jogaratnam

*International Journal of Contemporary Hospitality Management*, 2005

The paper analyses the findings on the survey of IT technology & they indicated that the decision makers did not seem to understand the importance of IT Technology that is essential for developing business strategies and hence were reluctant to use IT for better performance which would have eventually made their work easier.

Information technology (IT) applications in the hotel industry have largely been devoted to the handling of the routine operational problems that crop up while running a hotel. Before the hotel industry has been criticized to make full use of IT.

#### 3.1.3 Boutique hotels: Technology, social media and green practices

Denise Kleinrichert, Mehmet Ergul, Colin Johnson, Mert Uydaci

*Journal of Hospitality and Tourism Technology*, 2012

The major purpose of this paper is to link consumer use of technology to two very popular themes in the hospitality industry: boutique hotels and environmental responsibility.

Anyways these hoteliers generally reported use of varying regional standards for legitimizing their green practices. Istanbul hoteliers reported on maintaining international standards for legitimizing their green practices but did not seek any of the technology.

#### 3.1.4 Technology's effect on hotels and restaurants: Building a strategic competitive advantage

Dean A Koutroumanis

*Journal of Applied Business and Economics* 12 (1), 72-80, 2011



The strategic analysis methodology for evaluating and taking advantage of current and future technological innovations for the hospitality industry. The changing face of technology has played an integral role in the development of the hotel and restaurant industry. A review regarding the growth of technology in the industry was linked to the development of strategic direction. Every hotel focuses to have the best technology as in this competitive era consumer may focus on getting the comfort first.

### 3.1.5 Self-service technology and the service encounter

Amanda Beatson, Nick Lee, Leonard V Coote

The Service Industries Journal 27 (1), 75-89, 2007

Self-service technology is affecting the service encounter does affect the future growth of the hotels as in today's era technology places an important role in every industry and customers look for their uniqueness and comfort. The reduction in personal contact through self-service technology may affect assessments of consumer satisfaction and commitment, making it necessary to investigate self-service technology usage. Thus, this paper presents a framework for investigating the impact of self-service technology- consumer satisfaction and on a multi-dimensional measure of consumer commitment.

**4.1 Profile** – Crowned Plaza Pune is one of the InterContinental hotels which came up in 2003; this independent corporation InterContinental Hotels Group (IHG) was established after Six Continents split into two companies: IHG focuses on hotels and soft drinks. Crowne plaza has one of its branches in pune near pune station and is one of the renowned 5 star hotels.

### 5.1 Research methodology -

5.1.1 Population- 23 five star hotels in Pune

5.1.2 Sample design- 1 Hotel Crowne Plaza Pune

5.1.2.1 Sample size - The questionnaire was collected from front office of crowne plaza pune

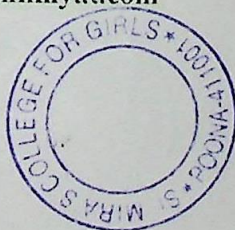
5.1.2.2 Sample method – Convenient sampling

5.1.2.3 Sample elements - the study comprises of front staff of Crowne Plaza

5.1.2.4 Data Collection – the researcher collected primary data through questionnaire method and secondary data through related websites and books.

### 6.1 Data analysis -

1. The technology used for parking at crowne plaza pune is valet parking at owner's risk. The entrance does not cover any technology and the doors are opened manually for the customers. There is a metal detector at the entrance which beeps if you have a phone with you.
2. The bookings for the hotel rooms are done through mobile apps via IHG apps i.e. intercontinental hotels where all 5 star hotel bookings are done.
3. The room service helps the customers to carry their bags to the rooms through elevators and trolleys. They work manually with more of human work.





4. The idea of erecting intelligent hotels is that the hotel uses voice activated services for attending the calls of the customers.
5. Impact of mobile apps technology used in hotels to make services better for their customer's they allow customers to order the food through phone calls and manage event reservations over the call as well as when they reach the hotel.
6. Human touch is basically the concept of crowne plaza. They are not upgraded with any kind of technology, the rooms are opened with WING Card keys and are not digital based.
7. The hotel does their branding / marketing through advertisement, hoardings, social media and personalized apps.
8. The billing system takes place via online payments and the bills are sent on their emails to reduce the paper work.
9. The software used by the hotel for the billing system is OPERA system and trainings are given to the employees for how to use opera, virtual trainings and on field trainings.
10. Crowne plaza upgrades its technology and system once in 2-3 years.
11. The purpose of most visits to crowne plaza is for stay and meetings / conferences.
12. Crowne plaza is divided into 11 floors, 8 floors for guests, 1 for staff and 2 banquets.  
The hotel has 176 rooms, 3 elevators, 1 bar, 1 gym, 2 restaurants, 1 pool, 1 poolside restaurant and 1 banquet.
13. The availability of room is checked on opera system and the chef receives the orders through KOC system, they punch in the system through MICROS and 1 order sheet goes to the room service and another to the kitchen.

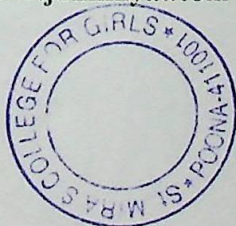
#### 7.1 Conclusion-

1. Crowne plaza being one of the most renowned hotels in Pune would be updated and upgraded with the latest technology but it believes in working manually than using any kind of technology.
2. From the entrance to the billing or ordering food it is unlike other hotels which follow the same system of manual work.
3. Crowne Plaza works manually and hardly uses any technology such as calls over phone and online booking.
4. They are less friendly towards the latest and new technologies used by the other hotels to reduce the manual work.
5. Crowne Plaza is preferred by people due to its location and especially for business meetings.

#### 8.1 Suggestions –

1. Crowne Plaza being a 5 star hotel needs to upgrade itself for using the world latest technology that makes the stay easier for the customers and makes the work easier and handy for the staff.
2. Like other 5Star hotels have upgraded their technologies and have become technology friendly, like using mobile apps to unlock the room doors, mobile orders, etc.

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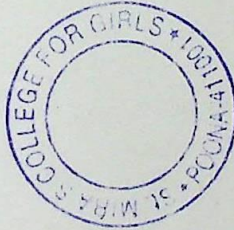


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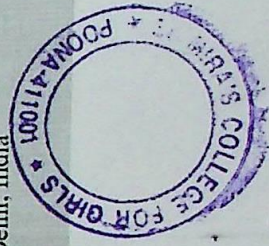
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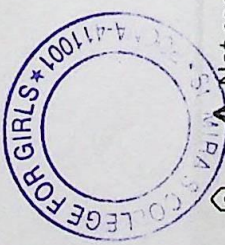
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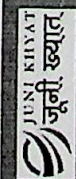
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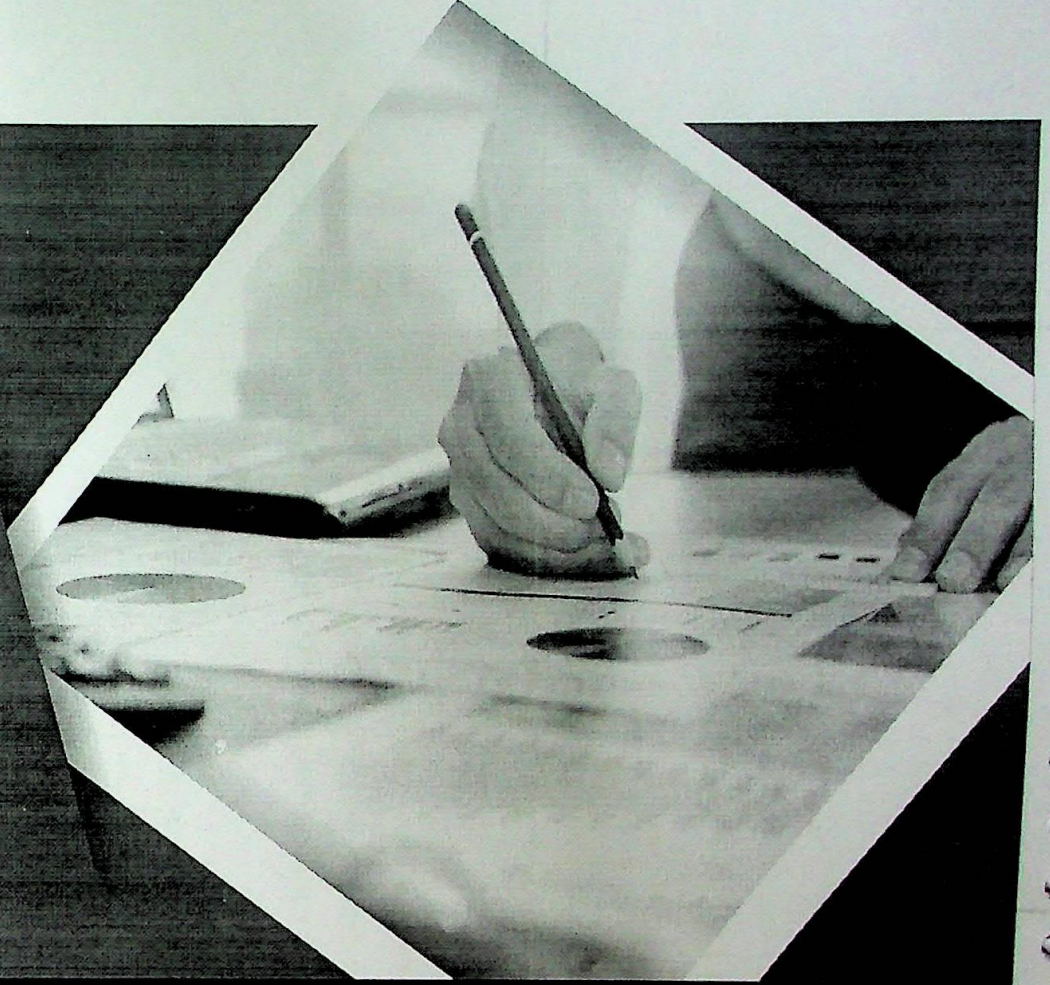
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# A Study of Customers' Perception of Efficiency and Effectiveness of Waiting Line Management in Private Hospitals in Pune City

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Maharashtra,

## ABSTRACT –

Waiting is ubiquitous. It's even more painful in the case of essential services like healthcare. This study focuses on the issue of waiting lines in private hospitals. The study attempts to understand the reasons behind waiting lines and the impact of it. Furthermore, the study attempts to analyse the expectations and perceptions of customers (patients) about the healthcare OPD services.

**KEYWORDS**-Customer expectation, customer perception, effectiveness, efficiency, waiting line management, healthcare

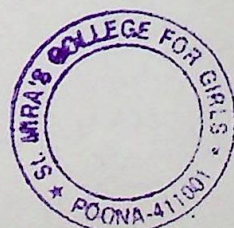
## 1. INTRODUCTION

Services as a product is very distinct. It lacks intangibility and can be only experienced through feel. It is perishable and thus can be provided on the spot with no possibility of storage for provision for future. It is inseparable. The production and consumption of services is simultaneous. It is heterogeneous and thus the handling and experience may vary between customers and can be different for the same customer.

Healthcare Industry is engaged with provision of essential services. It is meant for public utility and entrusted with the benchmark of nobility. Though, it is categorised into public, private and voluntary organizations, the goal of public service is primary. But over the years, people have formed images and thus expectations from Government and Private Hospitals differently.

Though the masses have several issues concerning functioning and performance of the health care, this study focuses on delays in provision of services to the patients (who are interchangeably referred as customers). Timeliness is one of the important criteria of quality of services. It is more crucial in case of healthcare services as the delay can cost a life as well apart from anxiety, pain, stress, and increase in severity of disease etc.

### 1.1 INDUSTRY OVERVIEW



Healthcare industry is a one of the largest sector of our economy. It's growing at the same pace as software and pharmaceutical industries. The sector is credited with employment provision to 4 million people along with allied industries.

Healthcare industry comprises of providers of diagnostic, preventive, remedial and therapeutic services. The composition of healthcare in India also includes manufacturers of medical equipment and medicine. Health insurance providers are also the part of this industry. Further, the sector is seen categorised as government owned, private sector and voluntary organisations.

The future prospects of the industry are quite promising.

According to IBEF, Indian healthcare market can grow three-fold to ₹8.6 trillion (US\$ 133.44 billion) by 2022. The growth in the sector can be attributed to many reasons, prime being its competitive advantage. Indian healthcare enjoys competitive advantage because of highly skilled and professional doctors and cost effectiveness. Cost effectiveness has led to increase demand for medical services from people across globe. Thus medical tourism is on surge. Apart from this government initiative like Ayushman Bharat, Pradhan Mantri Jan Arogya Yojana, and Indradhanush etc. shows government's efforts towards development of this sector. To further emphasise its efforts Government of India aims to increase healthcare spending to three percent of the Gross Domestic Product (GDP) by 2022.

## 1.2 STATEMENT OF THE PROBLEM

The focal point of the study revolves around finding out the causes of delays leading to waits faces by patients in provision of health care services. The study also attempts to analyse the physical and psychological cost associated with the waits and borne by the patients.

Further, the study also looks at this problem as question of trade-off between cost of resources and demand for them. That can also be inferred as to find out the effectiveness and efficiency of the hospitals used to reduce the waiting lines in the hospital.

## 1.3 OBJECTIVES

1. To analyse the components of queue management
2. To study the reasons for waits in OPDs of a private hospital.
3. To understand the concept of physical and psychological costs of waiting to the customers and analyse it in the case of healthcare industry
4. To study the provisions made by hospitals for waiting line management, its effectiveness and its impact on satisfaction level of patients.
5. To find patients' preference between government hospitals and private hospitals.

## 1.4 SCOPE





The study intends to examine waiting line management at Noble Hospital Pune. Main parameters of the study are number of patients, appointment systems, queue handling, facilities provided to the patients, psychology related to waiting and customers' preference of health care services from private hospital.

The study was completed in the outpatient department of Noble Hospital.

The data collection was done through primary methods of questionnaire, interview and observation with patients as respondents. The secondary data was collected through journals, websites, research papers and books.

## 1.5 HYPOTHESIS

**H<sub>0</sub>:** Patients' perception related to waiting line management matches with the expectations about it.

**H<sub>1</sub>:** Patients' perception related to waiting line management doesn't match with the expectations about it.

**H<sub>0</sub>:** Patients perceive government hospitals and private sector hospitals equally efficient in waiting line management. Thus, the preference is same.

**H<sub>1</sub>:** Patients do not perceive government hospitals and private sector hospitals equally efficient in waiting line management. Thus, the preference is not same.

(A) Private Sector hospitals are more efficient in waiting line management than Government hospitals. Thus, private sector hospitals are preferred over government hospitals.

(B) Government hospitals are more efficient in waiting line management than Private Sector hospitals. Thus, government hospitals are preferred over private sector hospitals.

## 1.6 SIGNIFICANCE

It is said that a good research should hold relevance to the problems of the society. This study attempts to address a pressing issue which is pain point for everyone. Delays in provision of services are not only a bother but can assume critical consequences in case of healthcare. When analysed from service providers' point of view: it's a trade-off between demand for resources and the cost to be incurred. If not planned properly, it may lead to loss of patients (customers).

As far as patients are concerned criticality of required services build up certain expectations. The gap between perception and expectation creates dissatisfaction, annoyance, bad word of mouth etc.



Hence the study holds practical relevance in understanding the causes of delays and its consequences. Also, coming up with practical solutions adds to the significance.

## 1.7 LIMITATIONS

The study suffers from several limitations like small sample size, subjective bias of researchers and respondents, lack of cooperation from respondents and limited time frame of research.

## 2. THEORETICAL BACKGROUND

### 2.1 DEFINITIONS

- **Services**-The American Marketing Association define “service as activities benefits and satisfaction which are offered for sale are provided in connection with the sale of goods.”
- **Hospitals** –an institution providing medical and surgical treatment and nursing care for sick or injured people.
- **Private Hospital**- According to Medical Dictionary for the Health Professions and Nursing © Farlex 2012
  - “1. A hospital similar to a group hospital except that it is controlled by a single practitioner or by the practitioner and the associates in his or her office.
  - 2. A hospital operated for profit.”
- **Waiting Line Management** –According to Leseure, M. “Waiting line management deals with understanding and modeling queues, and with taking managerial actions to reduce waiting time for customers.”
- **Waiting Lines**-Based on WordNet 3.0, Farlex clipart collection- “it’s a line of people or vehicles waiting for something”.
- **Customers Perception** -The formal definition of customer perception according to Business Dictionary is, “A marketing concept that encompasses a customer’s impression, awareness and/or consciousness about a company or its offerings.”
- **Customer Satisfaction**- Philip Kotler defines “customer satisfaction as a 'person's feeling of pleasure or disappointment, which resulted from comparing a product's perceived performance or outcome against his/her expectations'.”
- **Customer Preference**- Deepa Guleria, Dr. Yashwant Singh Parmar (IJMRR) Consumer preferences are defined as the “subjective (individual) tastes, as measured by utility, of



various bundles of goods. They permit the consumer to rank these bundles of goods according to the levels of utility they give the consumer.”

## 2.2 CHARACTERISTICS of SERVICES

- i. **Intangibility-** Services lack the property of touch and sight. They can be only felt. The repercussion of this is felt by both the customers and service providers. The customer in the absence of tangibility finds it difficult to trust quality, worth and suitability of the product. The service provider on the other hand struggles to prove the quality of his service product. This can be resolved through service providers investing well in promotions, infrastructure and customer service. Also, the prices should be fixed carefully.
- ii. **Inseparability-** In case of services the production and consumption takes place simultaneously. This also infers the presence of producer and consumer together thereby giving rise to customers' judgement about the service in real-time. The service providers have to be utmost careful with planning and execution of their production otherwise this would lead to loss of customers.
- iii. **In-storability-** Services are perishable. The demand and supply are not time and space spaced out. This leads to fluctuation in prices as per the peak and slack demands.
- iv. **Inconsistency-** Services lack standardisation. The outcomes may vary because of human factor. This leads to negotiation in prices and doubt over the quality. This can be resolved primarily through automation and training of personnel and customers.

**2.3 Demand Management and Waiting Lines Management-** To comprehend the issue of waiting lines it's important to understand following concepts-

**2.3.1. Capacity constraints-** every service firm needs to be aware of the functional capacity in terms of time, labour, equipment and facilities. It should know the extent to which they can utilise it and the shortage of it. This approach would help them to think of workable solutions to meet the demand.

**2.3.2. Demand patterns-** The trends of demand situation faced by a firm will be useful to reduce uncertainty in forecasting and hence effective planning. A service firm may face irregular demand; demand below, up to and or above optimum level.



**2.3.3. Strategies for matching capacity and demand-** When a firm has knowledge of its demand pattern and capacity constraints, it can fruitfully use the information to develop strategies to match demand and supply. The battery of strategies can be placed under either demand shifting or capacity flexing. The former relates to attempt shifting of demand from peak demand to slack demand period and latter relates to stretch, and adjust the capacity as per demand situation.

**2.3.4. Demand shifting strategies –** If demand is low use heavy promotion, revamping service offer, offering discounts, longer hours of operation etc. If demand is high strategies like communication of busy operation hours, incentives for shifting to non- peak period, charge high price etc.

**2.3.5. Capacity flexing strategies-**If demand is too high the firm may resort to cross train employees, hire part-time employees, overtime, rent or share facilities, outsourcing etc. If the demand is too low the firm can use the period for renovation, allowing vacations to personnel and may take actions of lay off.

**2.3.6. Waiting line strategies-** It's quite possible that in spite of all efforts there's waiting in the system. The most common strategies adopted by firms to reduce queue length and waiting duration includes following-

- i. **Operational logic-** The firm should study the bottlenecks in the system. It's important to cut- off avoidable steps to improve processing and delivery times.
- ii. **Reservation-** To reduce uncertainty and manage demand more efficiently the firms can set up a reservation system.
- iii. **Differentiation among customers** based on criteria like urgency of need, importance of customers, processing time etc.
- iv. **Making waiting fun and tolerable-** Provision of facilities like television, magazines, waiting areas etc. to make it less bother to the students.

## 2.4 CUSTOMER SATISFACTION IN SERVICES

Marketing sees customers as pivotal point of all decisions. The customer is undisputed king of the market. He is the decider of quality.

Services being intangible are experiences based. The customers' satisfaction depends on two important parameters expected quality and perceived quality. The former relates to expectations from a service product developed by customers on the basis of past experiences,



need, word of mouth communications and promotions and latter relates to the experience felt after consumption of services.

If we denote Expected Service = ES and Perceived Service= PS

ES < PS=Delight (Super satisfaction)

ES = PS= Satisfaction

ES > PS= Dissatisfaction

In case of services, Parasuraman and Zeithaml suggested several dimensions critical to customers' evaluation of service quality. A version of these criteria is RATER that stands for Reliability, Assurance, Tangibility, Empathy and Responsive. RATER basically deals with dependability, fulfilling promises, physical evidences, being in customers' shoes and promptness in service delivery.

SERVQUAL is the instrument to examine and analyse service quality.

## 2.5 EFFECTIVENESS AND EFFICIENCY OF A SERVICE PRODUCT

The customer of a service expects the service provider to ensure there are full-bodied streamlined systems and processes in place that are dedicated to deliver right quality, safe and reliable services.

Efficiency of services relate to delivering services to its customers in the most cost-effective manner without compromising on relative quality of the service.

The firms should analyse effectiveness through mystery shopping, follow-up survey, social media monitoring, documentation analysis etc.

## 3. REVIEW OF LITERATURE-

**3.1** The Impact of Waiting in Line on Consumers. Chebat, Jean-Charles & Filiatrault, Pierre. (1993)-the study was conducted to find out the impact of emotions on attribution process and if emotions and attribution impact the perceived service quality in a bank.

It was found out that service quality is evaluated by customers based on the experience after its delivered and the process of delivery. It also establishes the impact of quality not only on the receivers but also on the consumers who are observing it. Consumers mood affect the interpersonal aspect of the touch points. Attribution also shows positive impact on service quality.

**3.2** Analysis of Delays Due to Waiting Lines in Healthcare Delivery for Sustainability by Prema Mahalaya and Dr.B. B Deshmukh

The study was carried out to find out the waiting line problems in small hospitals and the methodology adopted by these hospitals to resolve the issue. It also focuses on the



challenges faced in queue handling. The study found out that waiting lines are a serious issue in even small hospitals thus requiring proper management to tackle the issue. These hospitals try to cut down queues by employing assistant doctor for the senior doctor and early discharge of non-critical patients. Some of the challenges faced in waiting line management by these hospitals are irregular patient flow, time stretch in certain cases and cost of additional resources.

### 3.3 Operational Strategies for On Demand Personal Shopper Services by Alp Arslan Niels Agartzt and Mathias Klapp

The study focuses on a personal shopper services to customers request thus creating a sequential decision problem. The findings of the study bring out three insights:

1. Personal shoppers are more useful in terms of saving time.
2. The approach helps to save considerable time by consolidating the shopper list.
3. It also leads to better shopping by splitting request according to different stores.

Thus, the study finds an innovative way of handling the waits and delays faced by shoppers.

### 3.4 Queuing Theory: A Case Study to Improve the Quality Services of a Restaurant by Lakhan Patidar, Trilok Singh Bisoniya, Aditya Abhishek, Pulak Kamar Ray

It's a case study on application of queuing theory in a restaurant name as Bapu Ki Kutiya. The authors found out that the two most important decision variables involved in managing orders are arrival rate and service rate. The restaurant experiences half the utilization rate on week days as compared to weekends. Considering this fact restaurant should calculate arrival rate, service rate, utilization rate, waiting time in queue and the probability of balking and plan for improvements in the system.

### 3.5 Impact of OPD Waiting Time on Patient Satisfaction- Dr (Brig) Anil Pandit, Er Lalit

Varma, Dr. Amruta. P.- The study was carried out with the major objectives of finding out average time spent by the patients in OPD, reasons for delays during the patients' visit and patients' satisfaction with the services. Some of the major causes identified in the study were- doctors' unavailability due to unpunctuality, doctors' going on round, improper scheduling, unavailability of residents for procedures waiting time for consultation and waiting time for billing. Some of the suggestions made by this study includes displays of information regarding doctors' timings and availability, using online platforms for appointment, making laboratory reports available at the laboratory counter and ensuring doctors availability during the OPD timings.



**3.6 The Impact of Waiting Time on Patient Outcomes: Evidence from Early Intervention in Psychosis Services in England- Reichert and Jacobs**

The study was conducted on EIP Services (England) with the objective of understanding the relationship between waiting times and patient outcomes. The study typically deals with early intervention in Psychosis and studies the patient outcomes after twelve months. The study hints at worsening of patients' condition along with other reasons especially because of waiting. The study reveals more days of in-patient care and more health experts are linked with poor follow-up outcomes. Longer the waiting time more worsening of the patients' conditions on different sub-dimensions namely- behaviour, impairment, symptoms and social.

**4. PROFILE OF THE ORGANISATION**

Noble Hospital was established in the year 2005 under the leadership of Dr Dileep Mane serving as Managing Director. The vision of Noble Hospital is to achieve standards of excellence which become a benchmark of healthcare practice

Noble Hospital is the First South East Pune's NABH Accredited Hospital. It is the youngest Green OT Hospital. It is a 320 Bedded Multispecialty tertiary Hospital with all facilities under one roof. Noble Hospital Annex has 50 bedded dedicated Oncology Ward, 10 bedded ultra-modern ICU with HEPA filters and laminar flow supported by a 27 bedded Nephrology Unit and additional 4 Operation Theatres.

The hospital is proud to have a team of world class doctors and surgeons well supported by trained nursing staff dedicated to serve patients in wide range specialties such as Medicine, Gynaecology and sports medicines. The hospital has fully equipped super specialty units such as Cardiac and Critical care, Brain and Spine Surgery, Robotic, Nephrology and Kidney Transplant, Diabetes and Obesity, Oncology, IVF and Robotic Joint Replacement, Anorectal Surgery, Intra-gastric Balloon Placement, Bariatric Surgery, Angioplasty, Anti-Aging Treatment, Appendectomy, Epilepsy Surgery, Hip Replacement, Prostatectomy, Pace Maker Implantation etc.

Further the hospital is privileged to have a Clinical Research Team and an all-inclusive Wellness Wing. The wellness Wing with AFIH qualified doctors' team is committed for corporate needs. The hospital works with good HIS system titled as Lifeline Suite providing a complete paperless system and MCI reports.

In cognizance of its responsibility towards the community, the hospital organises healthcare awareness programs for the poor sections of the society. The hospital regular commits itself to such programs on international level as well.



The dedicated services have brought laurels to the hospital in the form of various National and International accreditations.

## 5. RESEARCH METHODOLOGY

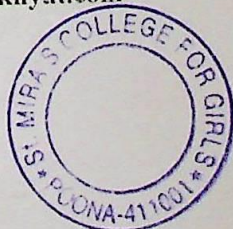
- i. **Research type-** The study is descriptive and analytical
- ii. **Nature of the study-** Quantitative Nature
- iii. **Variables in the study-**
  - Dependant variable – effectiveness and efficiency of waiting line management.
  - Independent variables- number of counters, registration counters, service requirements, the average customer wait time, the average amount of time it takes to service a customer, all feedback (both positive and negative) from customers, patient behavior, patient perception
- iv. **Sampling Plan-**
  - Population- According to Pune Municipal Corporation
    - Government Hospitals- 21 approx. in
    - Private Hospitals- 662 approx.
  - Sample Size- 28 patients
  - Sampling Method- Random Sampling Method
  - Class of respondents- Patients
- v. **Tools of data collection-** This research is based on Primary and Secondary data.
  - Primary source for data collection – Survey and Interview Method through structured questionnaire and observation method
  - Secondary source for data collection- Books, Journals, Published reports, Monthly Magazines, Related websites
- vi. **Questionnaire-** Structured Questionnaire using Likert scale will be developed.
- vii. **Tools for Data Analysis**
  - Descriptive Statistics- Arithmetic Mean, Percentage
  - Graphical methods -Bar diagram, Pie Chart and Line diagrams

## 6. DATA ANALYSIS AND INTERPRETATION

### 6.1 Section A

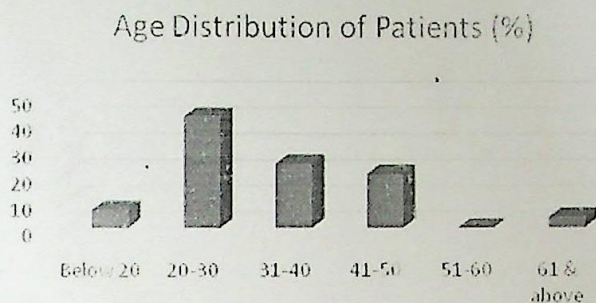
#### 6.1.1 Demographic Profile-

The study was conducted on 28 patients who visited different OPDs namely- General physician, Gynaecology, Paediatrics and Ophthalmology.



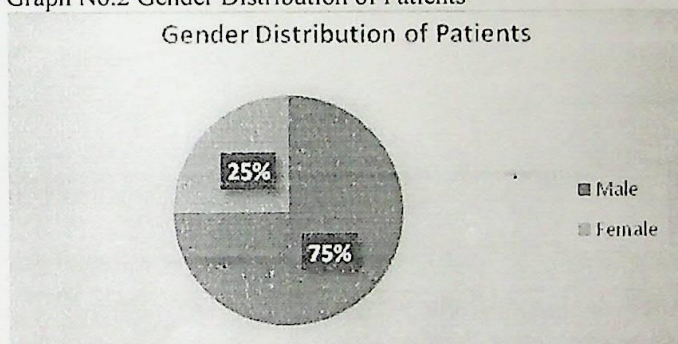


Graph-1 Age Distribution of Patients



According to Graph No.1 majority of the respondents 40% belong to age group 20-30 years and there was no patient in the age group 51-60 years.

Graph No.2 Gender Distribution of Patients



According to graph 2 sample under study consisted of 75% male and 25% females.

## 6.2Section B

### 6.2.1 Patients Preference Regarding Appointments

Table No.1 Patients Preference Regarding Appointments

		NO. OF PATIENTS	% Patients
1.	Always	16	57.14
2.	Most of the times	4	14.28
3.	Sometimes	6	21.42
4.	Never	2	7.14
		28	

Table No.1 shows that majority of patients (57.14%) always visit the hospital with appointments whereas only 7.14% people do not prefer appointments. This could be because



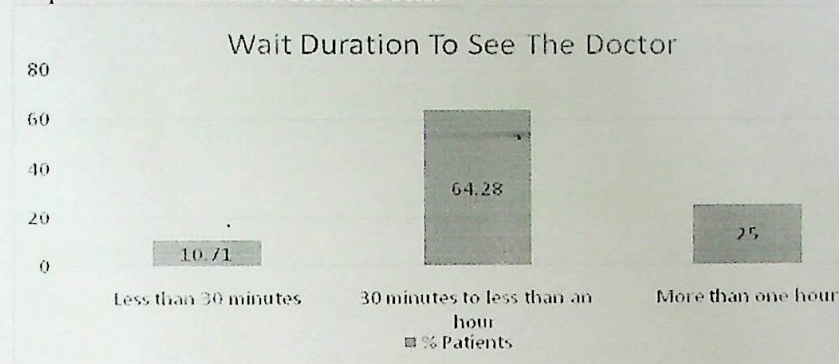
of difficulty in meeting the doctor without appointments in some cases the hospitals do not take without appointment.

### 6.2.2 Wait Duration to See the Doctor

Table No.2 Wait Duration to See the Doctor

	No. of Patients	% Patients
Less than 30 minutes	3	10.71
30 minutes to less than an hour	18	64.28
More than one hour	7	25

Graph 3 Wait Duration to See the Doctor



Graph 3 depicts that 64.28% patients experience half an hour to an hour duration from registration desk to meeting the doctor. There are around 25% patients who spent more than an hour for the visit. 10.71% patient experienced less than 30 minutes to meet the doctor.

The analysis shows that processes in hospitals have waits as a necessary feature.

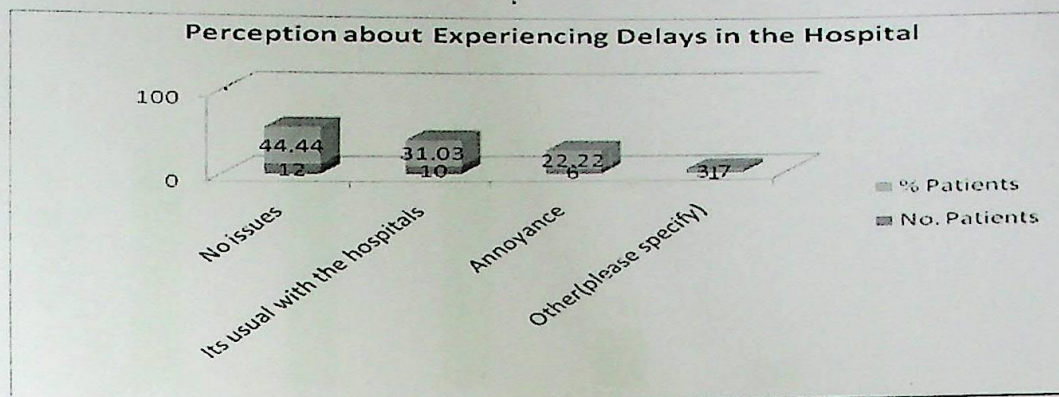
### 6.2.3 Perception about Experiencing Delays in the Hospital

Table No. 3 Perception about Experiencing Delays in the Hospital

	No. Patients	% Patients
No issues	12	44.44
It's usual with hospitals	10	31.03
Annoyance	6	22.22
Other(please specify)	1	3.7

Graph 4 Perceptions about Experiencing Delays in the Hospital



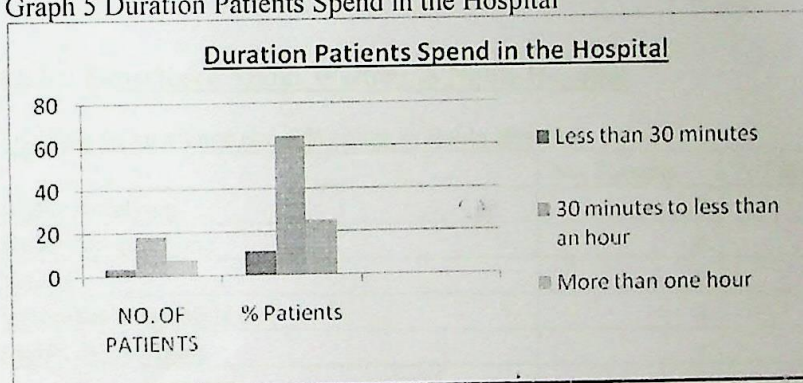


#### 6.2.4 Duration Patients Spend in the Hospital

Table No. 4 Duration Patients Spend in the Hospital

	NO. OF PATIENTS	% Patients
Less than 30 minutes	3	10.71
30 minutes to less than an hour	18	64.28
More than one hour	7	25

Graph 5 Duration Patients Spend in the Hospital



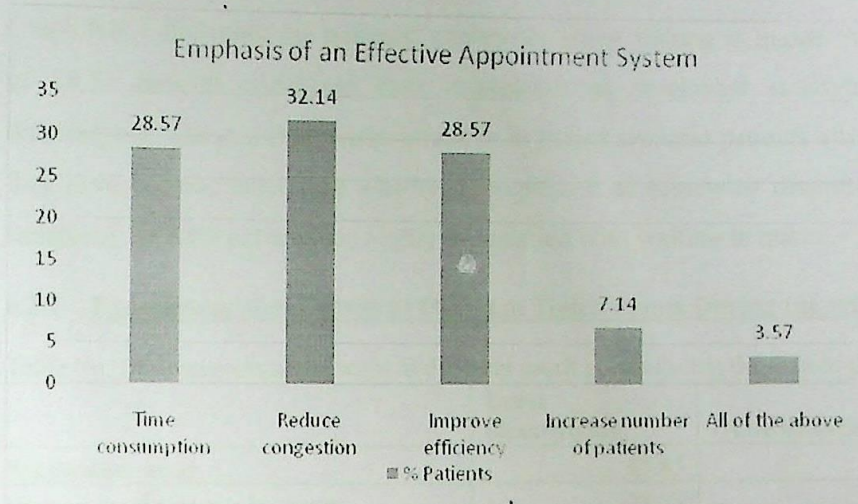
#### 6.2.5 Emphasis of an Effective Appointment System

Table No. 5 Emphasis of an Effective Appointment System

	No. Patients	% Patients
Time consumption	8	28.57
Reduce congestion	9	32.14
Improve efficiency	8	28.57
Increase number of patients	2	7.14
All of the above	1	3.57

Graph 6 Emphasis of an Effective Appointment System





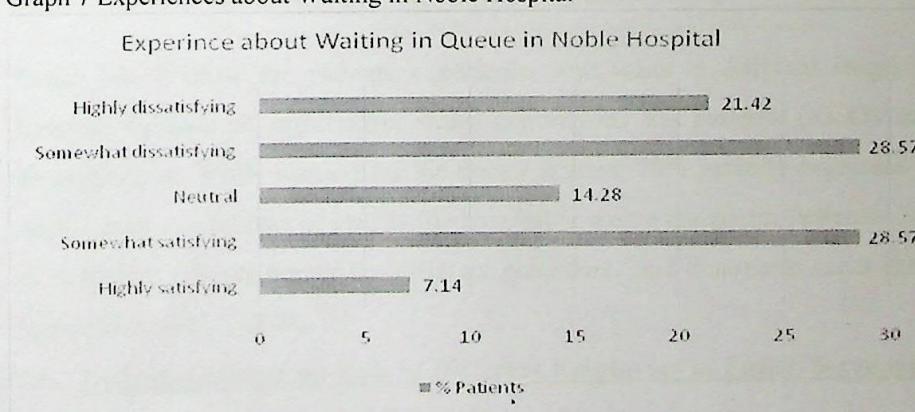
Graph 6 shows that 32.14% patients feel an effective appointment system reduces congestion followed by 28.57% patients feel it leads to time saving and higher efficiency. It is surprising that only 3.57% patients feel effective appointment system leads to all the benefits mentioned.

### 6.2.6 Experience About Waiting in Noble Hospital

Table No.6 Experience about Waiting in Noble Hospital

	No. Patients	% Patients
Highly satisfying	2	7.14
Somewhat satisfying	8	28.57
Neutral	4	14.28
Somewhat dissatisfying	8	28.57
Highly dissatisfying	6	21.42
	28	

Graph 7 Experiences about Waiting in Noble Hospital



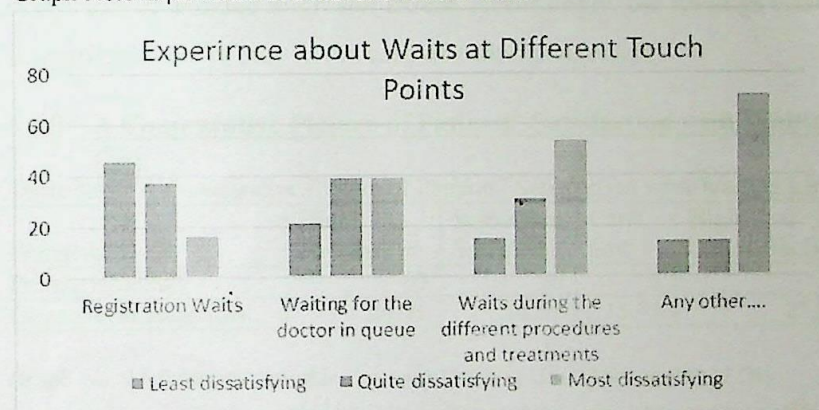
Graph No. 7 illustrates the patients' experience about waiting in queue. An equal percentage of 28.57 patients expressed their experience as somewhat satisfying and somewhat dissatisfying. The possible reason could be in Indian scenario patients always face waiting so they have become indecisive whether to express it as somewhat dissatisfying or somewhat satisfying. 21.42% patients are highly dissatisfied with waiting in queue.

### 6.2.7 Experiences about Waits at Different Touch Points During the visit to the hospital

Table No. 7 Experiences about waits at different touch points during the visit to the hospital

	Least dissatisfying	Quite dissatisfying	Most dissatisfying
Registration waits	45.83	37.5	16.67
Waiting for the doctor in queue	21.74	39.13	39.13
Waits during the different procedures and treatments	15.4	30.76	53.84
Any other....	14.3	14.28	71.42

Graph No.8 Experience at Different Touch Points



Graph No. 8 show the patients experience with waits at different stages of visit to the hospital. In case of registration waits majority of the patients (45.83) experience least dissatisfaction. While waiting for the doctor approx. 78% patients expressed dissatisfaction. As the most crucial part of visit to the hospital is seeing the doctor patients show a high level of impatience. Waits during the different procedures and treatments see a very high level of dissatisfaction of 53.84%.

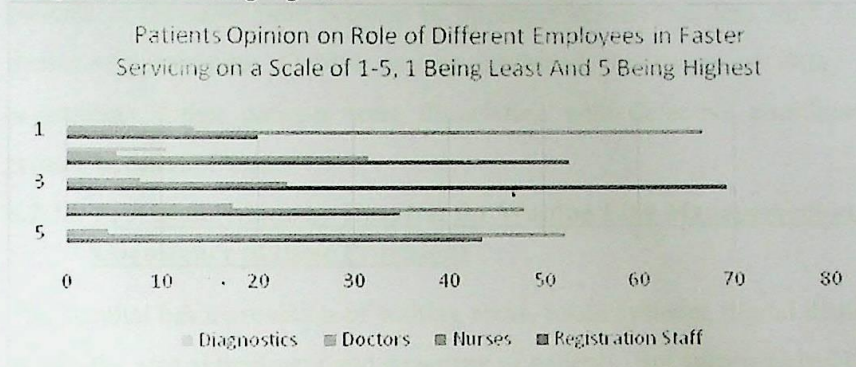
### 6.2.8 Patients Opinion on Role of Different Employees in Faster Servicing on a Scale of 1-5, 1 Being Least and 5 Being Highest



Table No.8 Patients Opinion on Role of Different Employees in Faster Servicing on Scale of 1-5, 1 Being Least and 5 Being Highest.

	5	4	3	2	1
Registration Staff	43.47	34.78	69.23	52.63	20
Nurses	52.17	47.82	23.07	31.57	66.66
Doctors	4.34	17.39	7.69	5.26	13.33
Diagnostics				10.52	

Graph No.9 Patients Opinion on Role of Different Employees in Faster Servicing on a Scale of 1-5, 1 Being Least and 5 Being Highest



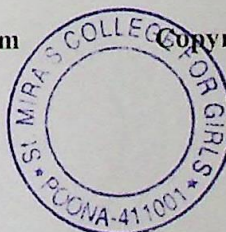
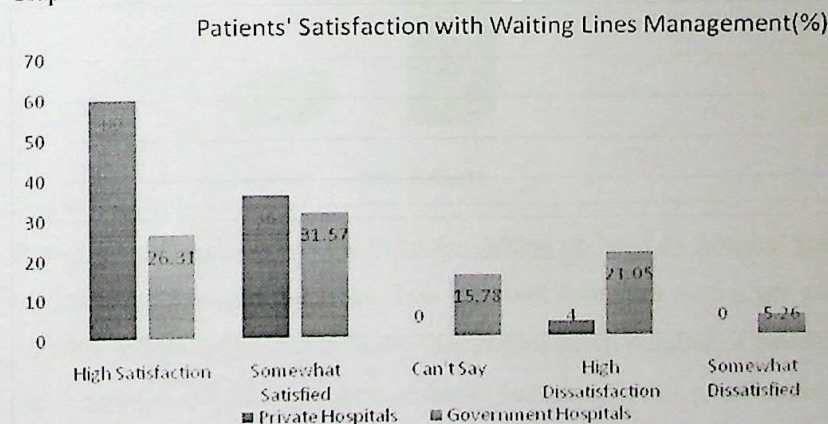
The above graph shows the patients opine that nurses and registration staff play the most important role in faster servicing. Thus, if the work is planned systematically and carefully delays can be avoided to greater extent. Accordingly, the findings establish doctors have very insignificant role to play in the case of wait management.

### 6.2.9 A Comparative Picture of Patients' Satisfaction with Waiting Lines Management (%)

Table No. 9 A Comparative Picture of Patients' Satisfaction with Waiting Lines Management (%)

Hospitals	High Satisfaction	Somewhat Satisfied	Can't Say	High Dissatisfaction	Somewhat Dissatisfied
Private Hospitals	60	36	0	4	0
Government Hospitals	26.31	31.57	15.78	21.05	5.26

Graph No. 10 Patients' Satisfaction with Waiting Lines Management (%)



As seen in the graph no.10 private sector is clearly seen as better in services as compared to government hospitals. 60% patients expressed high satisfaction with private hospitals as against only 26.31% expressing high satisfaction with government hospitals.

#### **6.2.10 Customers Perception About the Causes of Delays in Provision of Services in the Hospital**

According to majority of the patients (i.e. 43.08%) the most important reason is crowding of patients at the same time because of improper scheduling, less staff and popularity of the doctor. Approximate 13.04% patient attributed the cause of delay to time spent for registration. Other patients were dissatisfied with defective coordination and confusion created because of that.

#### **6.2.11 Provisions Made by Hospital for Waiting Line Management and Customers' Cognizance of these Provisions**

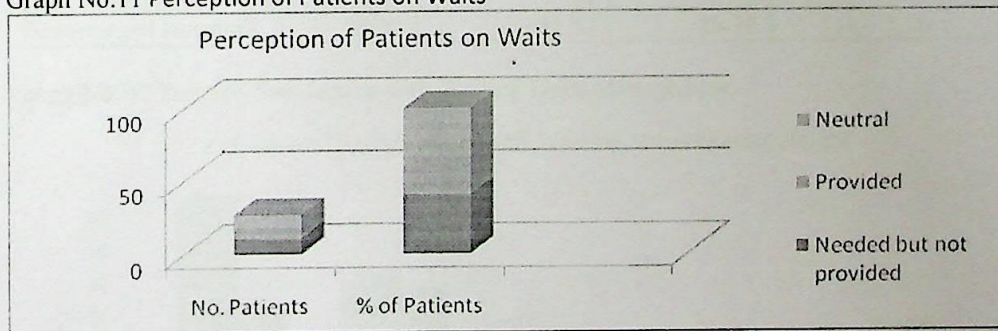
The hospital has a provision of waiting areas, token systems, digital displays and counters to handle the arrival treatment and departure of patients. But surprisingly 21% patients were not aware of token systems and digital displays installed for handling the waits. The possible reason could be because of lack of observation of patients.

#### **6.2.12 Perception of Patients About Updating on Status of Waits**

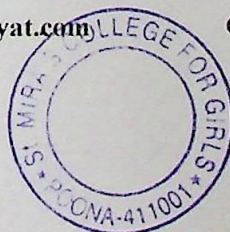
Table No. 10 Perception of Patients about Updating on Status of Waits

	No. Patients	% of Patients
Needed but not provided	11	40.74
Provided	7	25.92
Neutral	9	33.33

Graph No.11 Perception of Patients on Waits



A majority of patients feel the need for getting updated by hospital staff on status of waiting i.e. information regarding when their turn will come but do not get such assistance from the hospital. It was surprising to know that almost equal number of patients i.e. 33.33% have no such expectations. This could be probably because of same practice elsewhere.

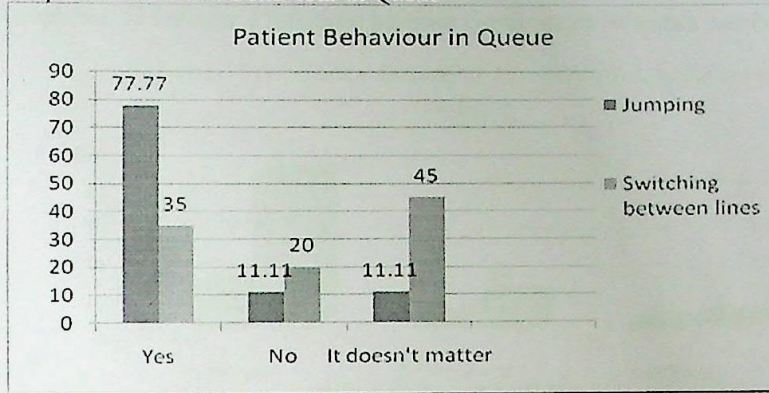


6.2.13 Patients' Experience on Patient Behaviour When Waiting in Queue in this Hospital

Table No. 11 Patient Behaviours When Waiting in Queue in this Hospital.

	Yes	No	It doesn't matter
Jumping	77.77	11.11	11.11
Switching between lines	35	19.8	44.2

Graph No.11 Patient Behaviour in Queue



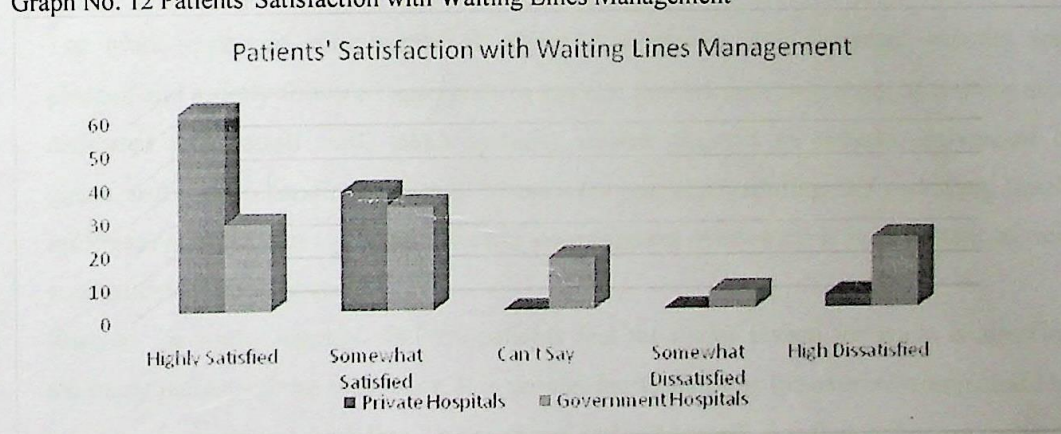
The above graph shows that patients have experienced jumping the queue and switching between lines while waiting in the hospital. A very high percentage of 77.77 patients have experienced jumping, but there are 11.11 % patients who don't see it as a bother. In the case of switching between lines 35% patients have experienced it and see it as a bother but a good number of 44.2% doesn't feel it matters.

6.2.14 Patients' Satisfaction with Waiting Lines Management

Table No. 12 Patients' Satisfaction with Waiting Lines Management

Hospitals	Highly Satisfied	Somewhat Satisfied	Can't Say	Somewhat Dissatisfied	High Dissatisfied
Private Hospitals	60	36	0	0	4
Government Hospitals	26.31	31.57	15.78	5.26	21.05

Graph No. 12 Patients' Satisfaction with Waiting Lines Management



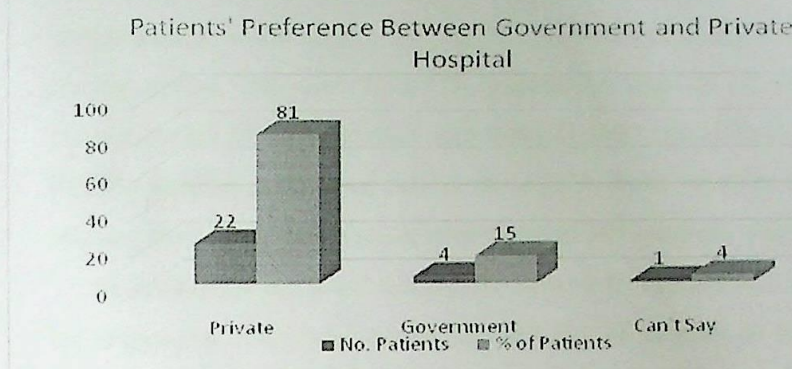


**6.2.15 Preference between Government Hospitals and Private Hospitals**

Table No. 13 Patients' Preference between Government Hospitals and Private Hospitals

	No. Patients	% of Patients
Private	22	81
Government	4	15
Can't Say	1	4

Graph No. 13 Patients' Preference between Government Hospitals and Private Hospitals



Graph No.13 reflects 81% patients prefer Private Hospitals as compared to only 15% patients preferring Government Hospital. According to the respondents the reason behind not preferring Government Hospital includes insensitive attitude of the staff, more time consuming, being crowded and preference for private hospital include reasons like state of the art equipment, better services, systematic approach towards patients.

**6.2.16 Patients' opinion on Provisions Made to Make Waiting Tolerable**

Majority of the patient i.e. 52% feel provision of TV, magazine etc. can help reduce boredom due to wait whereas a significant 33% opined that these arrangements do not make any difference. Few patients felt that Television should be use to show Knowledgeable Content.

**7. CONCLUSIONS**

- i. The most important components of queue management in a hospital includes well planned and strictly followed appointment system, provisions comprising of waiting area, dedicated registration staff, token systems, digital displays to indicate movement of queue, software to handle the data of patients for proper scheduling and servicing, timely information, sufficient staff and effective coordination. Above all it is important to treat your patents with utmost care.
- ii. Reasons for waits- Approx. 43.08% patients feel the major reason for waits is allowing too many patients at the same time. It is seen as inefficiency as the overcrowding could be because of improper scheduling, less staff and inflexible staff. Another important cause of



delays as found out turns out to be unreasonable long time taken for registration. Patients also opined that defective coordination and confusion also creates waits.

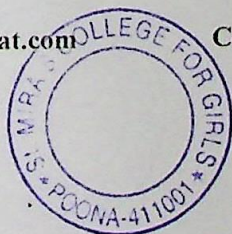
- iii. Patients' perception related to Physical Costs- Physical cost related to wait basically relates to the length of waiting and exertion. In this study it was found out that maximum waiting happens after registration to see the doctor followed by waiting at registration counter and during diagnostics respectively. Hence, also indicating the level of dissatisfaction in that order. That is, 78% patients expressed dissatisfaction while waiting for the doctor, followed by 54.17% dissatisfied because of waiting at the registration counter and 53.84% dissatisfied with waits during treatment procedures. Further majority 64.28% patients experience half an hour to an hour duration from registration desk to meeting the doctor. And a small percentage of 10% patients wait for less than 30 minutes.

Psychological costs of waiting are related to expectation, judgement, opinions and belief patterns. The study reveals that majority of patients do not see the full benefits of approaching hospitals with appointments. The foremost reason for taking appointments is to avoid jamming and to accommodate to the hospital requirements. Majority of patients (57.14%) always visit the hospital with appointments.

- iv. The hospital has a provision of waiting areas, token systems, digital displays and counters to handle the arrival, treatment and departure of patients. Approximately 21% patients didn't notice token systems and digital displays installed for handling the waits. The possible reason could be because of lack of observation of patients and irregular use of them. Another conclusion that can be drawn from this is that for any hospital system it's the registration counters and appointment systems that are seen as most vital to handle patients.

Waiting in hospitals have become such a common sight that patients have accepted it as a norm. The frustration of waiting gets expressed in the form of jumping the queue and switching between lines while waiting in the hospital. Though a very high percentage of 77.77 patients have experienced jumping are unhappy but approx. 11 % patients don't see it as a serious matter. The same practice goes with switching between lines where a good number of 44.2% doesn't feel it matters.

A majority of patients approx. 41% feel the need for keeping updated by staff on status of waiting i.e. when their turn will come but do not get such assistance from the hospital. Again an almost equal number of patients i.e. 33.33% do not want any such information. This could be probably because of lack of awareness about their right or being complacent about the situation. Again interestingly, majority of patients 52% feel



provision of facilities like TV, magazine etc. can help reduce boredom due to wait whereas a significant 33% deny the importance of these.

The study shows a majority of patients (approx. 50%) were dissatisfied with waiting line management. There were around 15% patient's neutral on their experience. There could be many reasons behind such observation. Noble Hospital is one of the prominent hospitals in that area thus receives a lot of patients from the vicinity and popularity of some doctors leads to too many patients at the same time creating long waits and difficulty in handling.

- v. Patients' preference between government hospitals and private hospitals- The study came to conclusion that people clearly prefer private hospitals over government hospitals because of the belief and experience that the treatment is much better and more convenient.

Majority (96%) of the patients are satisfied with private sector hospital as compared to 56% people expressing their satisfaction with Government hospitals. It's worth mentioning that these patients have experienced services from both the providers. As it 's observed in most of other cases be it banks, insurance or education, healthcare as well presents better services by private sector.

- I. In the case of first Hypothesis  $H_0$  (Null Hypothesis) stands rejected as majority of patients (50%) have shown dissatisfaction towards waiting line management. It's noteworthy Dissatisfaction= Perceived Quality is lesser than Expected Quality. Thus, Alternate Hypothesis stands accepted.
- II. In the case of second Hypothesis  $H_0$  (Null Hypothesis) stands rejected as 96% patients have shown satisfaction and preference towards Private Hospitals as compared to Government Hospitals. Thus, Alternate Hypothesis stands accepted.

## 8. SUGGESTIONS

Based on the observations and findings, this study put forward following suggestions-

- i. Most of the patients feel that dearth of staff is one of the main reason behind waiting lines. Hence, the management should hire more doctors. Management should take initiative to ensure punctuality of the doctors.
- ii. It was felt by the patients that because of the relaxed approach on the part of patients and staff towards appointment overcrowding taking place so implementing a stricter and planned appointment system can be fruitful.
- iii. It is also suggested that if the availability of doctors is increased for more time more patients can be benefitted.



- iv. Registration plays a very important role in reducing and managing waiting time. Few improvements can really bring out better results. It is suggested to hire more people for registration desks, during registration visiting time should be fixed, more responsiveness built in registration staff by orientation towards patients' needs.
- v. Employing Operational Logic-The hospitals should identify critical points which if not handled properly can create delays. Similarly, duplication of activities should also be avoided.
- vi. Miscellaneous suggestions- time scheduling to ensure faster processing per patient, acknowledging patient as customers, reducing paper receipts, regular and functional system of managing queues through token number and electronic display of queue.

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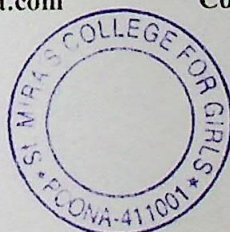
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# Journal of Indian Association for Child and Adolescent Mental Health - ISSN 0973-1342

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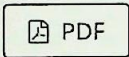
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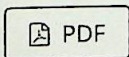
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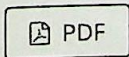
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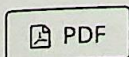
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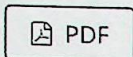
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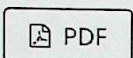
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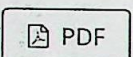
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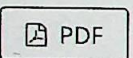
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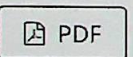
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Jaya Rajagopalan

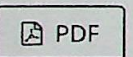
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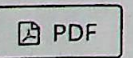
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*Jaya*  
Principal Incharge  
St. Mira's College for Girls

## Original article

**Attitudinal and Perceptual Dimensions of Body Image in Adolescents**

Jaya Rajagopalan

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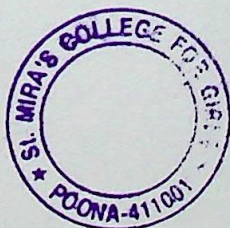
**Abstract**

**Background:** Body image is viewed as a multidimensional construct, a combination of perception and attitude regarding the body. Prevalence studies in body image concerns indicate the widespread incidence of body discontent in adolescent girls. The purpose of the study was to assess the attitudinal and perceptual dimensions of body image and the current level of body dissatisfaction, in Indian female adolescents.

**Methods:** Cross sectional observational study with a sample of 303 female adolescents, age 15-17 years. Informed consent was obtained from parents and participants. Materials used were Body Image Instrument, Self-Reporting Questionnaire-20 and Body Mass Index ratings.

**Results:** In the perceptual dimensions, more than 23.7% of the girls perceived themselves as overweight and obese while in actuality only 13% were overweight, thus indicating a trend towards prevalence of faulty body images. In the attitudinal dimensions, around 60% of the adolescent girls identified a thinner ideal body contour in comparison to their current figure. Significant discontent towards their current weight is experienced by adolescents within the normal BMI category, with more than 58.32 % of them desiring to be thinner.

**Conclusion:** In the context of weight concerns of Indian adolescents, there is an observable shift in preferences of body shape towards a thinner ideal. Adolescents experience a common dissatisfaction with their current bodies, irrespective of whether they desire to increase their body size or reduce it. These results hold great significance in the current context, wherein



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mental health professionals may witness an increase in body image disturbances and eating disorders, in Indian adolescents.

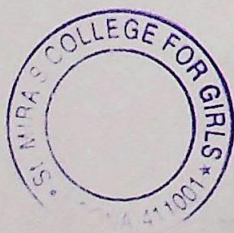
**Key words:** Body Image, Attitudinal dimensions, Perceptual dimensions

### Introduction

Body image is a complex construct, comprising of several different elements. According to Mazzeo [1], the multidimensional construct of body image consists of three important elements: (a) perception, (b) attitudes, and (c) preoccupation.

Body perception is characterized by the accuracy with which people estimate their body size. Although there is a physical reality to how large or small people are, their perceptions of their size may be inaccurate. Researchers studying the perceptual component of Body Image (BI) examine how individuals perceive their bodies and then compare the person's subjective experience of their body to measured objective body [2]. This difference between measures provides researchers with an index of accuracy as well as a quantitative measure of distortion [3].

Research suggests that the greater the discrepancy between perceived and actual body size, the more the body image disturbance. Studies show that girls with eating disorders tend to overestimate their body sizes in comparison to girls without eating disorders [4]. Thus, inaccurate perception of body may be a critical factor in eating disorders. However, body size overestimation is not unique to persons with anorexia or bulimia. In fact, Thompson and Thompson reported that the average global distortion level of body image perception is 25 % above accuracy [5]. Yet, there are very few studies that have examined body size perception in non-clinical samples, leaving a gap in knowledge of whether these same processes exist in the general population.



Attitudinal components of body image focus on the level of satisfaction/ dissatisfaction one has with one's body shape, size and weight [6]. Discrepancies between views of one's own current appearance and desired appearance, and discrepancies between the views held by others, namely peers and opposite sex, may be critical in understanding body image. In the current study, we examine participant's perceptions of their current body size as well as ideal size for themselves, also their perceptions regarding what others perceive as ideal, attractive and healthy.

Prevalence studies in body image concerns indicate the widespread incidence of body discontent in adolescent girls [7]. Studies report that over 80% of girls wanted to lose weight even though only 1.4 % of them were overweight. Also, 50 % of the girls who diet are of normal weight and 62 % of all girls are dissatisfied with their body [8]. Rodin, Silberstein and Streigel- Moore coined the term 'normative discontent' in the context of body image to describe the experience that most girls feel about their bodies in the current society [9].

Today, female bodies, particularly among girls, have become a source of distress and self-criticism, rather than a natural and pleasurable source of vitality, agency, and mastery [10]. Although body image dissatisfaction (BID) may be widespread and 'normative' among a majority of adolescent girls, its role in psychological disorders cannot be undermined. BID has been recognised as one of the strongest predictors of disordered eating [11].

Specifically, while discussing the weight concerns of Indian girls today, there is an observable shift in preferences of body ideals. Earlier, beauty ideals in India presumed a well-rounded figure with curves [12] and such inclinations remained stable till as recently as 1980s and 1990s. However, in the ongoing scenario, norms of beauty are dynamically altered in the subcontinent, becoming more and more similar to the global western standards and consequently perhaps becoming constricted. It now emerges that body dissatisfaction and disordered eating may be nearly as prevalent in Asian societies as they are in North



America and Western Europe [13]. There is a limited amount of literature related to Indian women's body image. Consequently, more research is needed on this group, which this study attempts to accomplish. With increased globalisation and spread of western ideals, mental health professionals may witness an increase in body image disturbances, in the Indian context. The study has been looked at as a first step in gathering much needed information on body image ideals of adolescent girls from the Indian culture. In this context, the purpose of the current study was to focus on the attitudinal and perceptual dimensions of body image and to assess the current level of body dissatisfaction in Indian adolescent girls.

## **Methods**

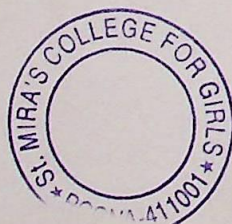
### **Operationalization of Concepts used in Research**

*Attitudinal dimensions of Body Image* -Individual's level of satisfaction with her/his body shape. A cognitive body dissatisfaction score will be calculated as the difference between these figure ratings (Current figure - Ideal figure). Thus, a positive score would indicate a desire for a thinner figure, while a negative score would indicate a desire for a larger figure.

*Perceptual dimension of Body Image* - Body perception is characterized by the accuracy with which people estimate their body size. The perceptual dimension will be assessed by comparing the actual body size as determined from the body mass index (BMI), with the perception of themselves as Thin/Normal/Fat/Too fat (as reported on the personal data sheet).

### **Sample and sample characteristics**

A sample of 303 adolescent girls was selected from the age group of 15-17 years. The inclusion criteria for the study was that participants had completed their 9<sup>th</sup> grade education or higher and were comfortable in the English language. The exclusion criteria were



participants who scored eight or more affirmative responses on the Self-Reporting Questionnaire (SRQ-20), to screen out for common mental disorders.

## Tools

### *Personal Data Sheet and BMI*

Participants were asked to mark their age, current weight, desired weight, how they viewed themselves (very thin, thin, normal, fat, very fat), whether they wanted to be thinner, whether they had ever tried to lose weight and whether they exercise, on the personal data sheet. The current weight and height of each participant was measured by the investigator after they completed the sheet. BMI was calculated from the height and weight of the participant.

### *Body Image Instrument*

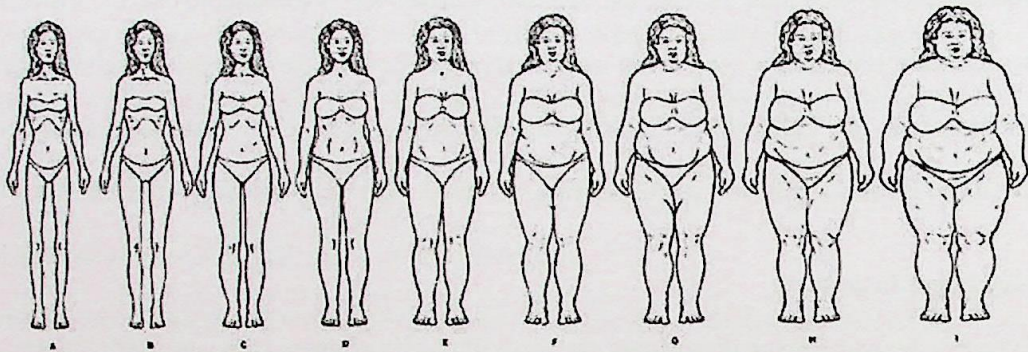
To assess the body image dimensions, the Body Image Instrument [14] was used. Pulvers' culturally relevant Body Image Questionnaire, adapted to reflect differences of body shape and size across ethnic groups, was used to measure current and desired body images. It consists of nine male and nine female front-view drawings of incremental sizes, ranging from very thin to overweight as test stimuli. Since the sample is restricted to girls, only the female drawings were used. Participants were required to choose figures which they consider represents the figure that: (a) they thought they were (b) they would desire to look like (c) they thought other girls would desire to look like (d) they thought men find most attractive (e) they thought men find most unattractive (f) they thought should be society's ideal (g) they thought was the most-healthy and (h) they thought was the most-unhealthy.

The scale shows satisfactory concurrent and content validity, with correlations reaching or closely approximating 0.70 to 0.80 standard for girls [14]. Cronbach's  $\alpha$  was calculated as 0.95, indicating excellent internal consistency among raters, as well as participant's own body image ratings. In the current study as well, participant ratings for body image correlated



highly with participant BMI ( $r = 0.67$ ) and with self-reported weight ( $r = 0.78$ ). The scale thus shows satisfactory concurrent validity in the current sample. The questionnaire thus, was validated for use in this population.

**Fig-1: Body Image instrument**

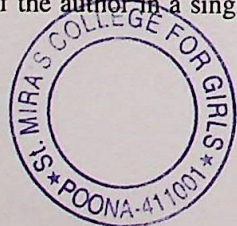


#### ***Self-Reporting Questionnaire (SRQ-20)***

For the screening of Common Mental Disorders, the Self-Reporting Questionnaire (SRQ-20) was used, an instrument developed for tracking psychiatric disorders validated in India and recommended by the World Health Organization (WHO) [15]. The cut-off point of eight affirmative responses to the SRQ-20 items was adopted to consider the presence of symptoms indicative of CMD; this cut off point has high sensitivity and a low rate of false positives [16].

#### **Data collection procedure**

The approval of the ethics review committee of the Department of Psychology, University of Pune was taken for the study. The data for this study was collected from schools in Pune city. Permission from the principal and consent from the parents was taken. Participation in the study was voluntary. The questionnaires were administered during class hours under supervision of the author in a single session. The purpose of the study was explained to the



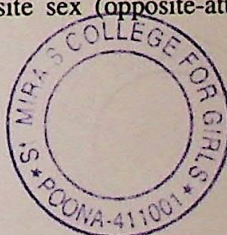
respondents and their informed consent was taken. The Personal data sheet, the Body Image Instrument and SRQ-20 were administered. No information revealing personal identity such as name, contact number was taken. It took approximately 20-25 minutes for participants to complete the questionnaires and to collect them. It was ensured that all the forms are completely filled and that no item was skipped. The data were screened for exclusion criteria. The data was entered in SPSS and was put for further analysis.

The data collection for the final study was preceded by a pilot study with 60 participants, to establish validity of the tools in the current sample, to determine whether design and methodology were feasible and to ensure that participants are able to comprehend the questions and do not experience any difficulty while answering the survey. The tools were validated for use in the current study.

### **Statistical Analysis**

The statistical analysis was done in SPSS (version 16). The data were checked for normality, and the scores were found to be normally distributed. The decision about sample size was based on the standard guidelines for ensuring adequate power [17]. Following these guidelines in order to ensure adequate power for the t test, a sample size of 100 would be required to achieve a power of 92% and a level of significance set at 0.05, for detecting an effect size of 0.5 between the attitudinal dimensions. The sample size in this study is thus more than adequate in regards to this criterion.

Mean and SD of scores of the participant characteristics, with reference to their BMI were derived. Attitudinal dimensions of Body image demonstrating the participant's level of satisfaction with their bodies were derived. This was done by calculating the frequencies related to amount of discrepancy between current perceived figure and ideal body shape contours. The mean and standard deviation of each sample for the ratings of current and ideal figure, figure perceived as attractive for the opposite sex (opposite-attractive) and figure



thought to be attractive for girls in general (girls-attractive), figure perceived as unattractive for the opposite sex (opposite-unattractive), figure perceived as society's ideal, figure perceived as most-healthy, figure perceived as most-unhealthy were also computed. Significance of difference between means of the above attitudinal dimensions was computed using paired sample t test.

Perceptual dimensions were derived by comparing the actual BMI (current weight/ current height) to the perceived BMI i.e. their perception of themselves as Thin/Normal/Fat/Too fat (as reported on the personal data sheet).

## Results

The mean scores and the range of scores of the participant characteristics, with reference to their BMI and its distribution are mentioned in Table-1 and 2.

**Table-1: Participant characteristics (N= 303)**

	Mean	SD	Minimum	Maximum
Age (in years)	16.78	1.02	15	17
Height(cm)	156.32	6.54	121.07	179.49
Current weight(kg)	53.27	8.35	36	89
Desired weight(kg)	50.24	5.38	35	70
BMI	22.06	3.41	13.96	34.74

**Table-2: Sample descriptive (Percentage) for Perceptual Dimensions, according to the Body Mass Index of participants**

BMI cut off points	Significance	Actual BMI (%) (n-303)	Perceived BMI (%) (n=303)	Participants perceiving themselves as fat (%) (n=69)	Participants wanting to be thinner (%) (n=148)	Participants who exercise (%) (n = 115)	Participants who tried to lose weight (%) (n = 113)
<18.5	Underweight	28.1	18.5	0	0	10.2	0
18.5- 24.9	Normal	58.4	57.8	47.8	58.3	48.2	51.6
>25	Overweight	8.25	20.8	28.9	22.5	27.6	34.9
>30	Obese	5.2	2.9	23.1	19.1	14	13.5

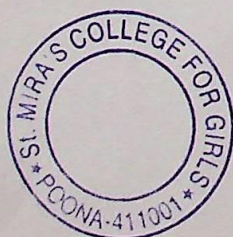


Table 2 also demonstrates the discontent that girls within the normal BMI category feel towards their current weight, with more than half of them desiring to be thinner.

### Attitudinal Dimensions of Body Image

As indicated in Table 3, participants in the study desired to have a body shape ranging from # 2 to # 6. None of them chose silhouette #1 or silhouettes upward from # 7. The percentage of total participants who chose silhouette #2 (underweight) depicting the desired body shape was 18.8 %. The table shows a high percentage (80.7%) of girls preferring to choose silhouettes (#3 and #4) that depict a normal body frame. However, the higher percentage within the normal body silhouettes is for # 3 which is thinner than the other two.

**Table-3: Frequency distribution of figure choices for desired silhouette<sup>1</sup>, according to the Body Mass Index of participants (N = 303)**

Categories/ silhouette number	#1	#2	#3	#4	#5	#6	#7	#8	#9	Total
Underweight	0	17 (20.0%)	39 (45.9%)	21 (29.4%)	3 (3.5%)	1 (1.2%)	0	0	0	85
Normal	0	35 (19.7%)	96 (54.2%)	39 (22%)	7 (3.9%)	0	0	0	0	146
Overweight	0	3 (12)	19 (76%)	2 (8%)	1 (4%)	0	0	0	0	31
Obese	0	2 (12.5%)	8 (50%)	5 (31.2%)	1 (6.2%)	0	0	0	0	41
<b>Total</b>	0	57 (18.8 %)	162 (53.4%)	71 (23.4%)	12 (3.99%)	1 (0.3%)	0	0	0	303

<sup>1</sup># 1 to # 9 indicates the number of the silhouettes from the Body Image Instrument. # 1 indicates the leftmost figure and #9 indicates the rightmost figure.

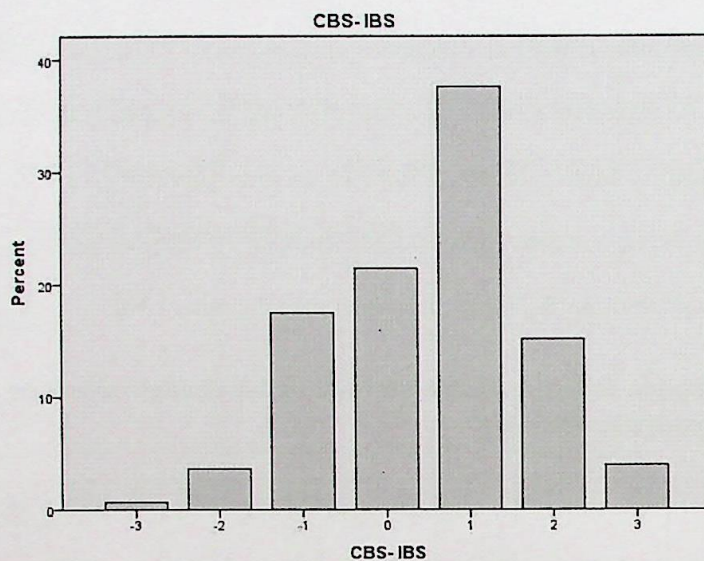
A body shape contour discrepancy score was calculated by subtracting the ideal figure chosen from the current figure perceived. Fig 2 displays the frequencies related to amount of discrepancy between current perceived figure and ideal body shape contours. Few girls in the sample desired a fuller figure than their current figure (18%). Roughly 22 % of girls selected





the same body contour for current and ideal figure. Around 60% of the girls identified a thinner ideal body contour in comparison to their current figure.

**Fig-2: Percentage of discrepancy between Current Body shape and Ideal Body Shape**



The mean and standard deviation of each sample for the ratings of current and ideal figure, figure perceived as attractive for the opposite sex (opposite-attractive) and figure thought to be attractive for girls in general (girls -attractive), figure perceived as unattractive for the opposite sex (opposite-unattractive), figure perceived as society's ideal, figure perceived as most-healthy, figure perceived as most-unhealthy are presented in Table 4. There was a significant difference ( $t(302) = 7.703, p < 0.001$ ) between current body shape ( $M = 3.68, SD = 1.17$ ) and ideal body shape ( $M = 3.15, SD = 0.77$ ). The mean of the figure that girls would perceive as most attractive was 2.95 (0.97), while the figure that they perceived that men would consider to be most attractive was an average of 3.11 ( $SD = 1.02$ ). The mean for the most-healthy figure was computed at 4.39 ( $SD = 1.62$ ), which is significantly different from that which is considered attractive by girls ( $t(302) = 14.98, p < 0.001$ ). Even though the participants considered a mean of 3.69 as society's ideal, the figures that they considered as



their personal ideal had a mean much lower than this. Similarly, there was a significant difference between the mean figure that was considered as their desired figure ( $M = 3.15$ ,  $SD = 0.77$ ) and the mean figure considered healthy ( $M = 4.39$  ( $SD = 1.62$ ), ( $t(302) = 13.57$ ,  $p < 0.001$ ). There is an absence of figures from the upper third of the scale for all parameters except figure considered to be unhealthy ( $M = 6.20$ ,  $SD = 3.78$ ) and unattractive by men ( $M = 7.96$ ,  $SD = 2.31$ ). This is a striking finding because even though girls in the sample perceived themselves to be represented across the complete scale, only the thinnest 6 contours were considered ideal and attractive. The frequency distribution of these two categories shows that both the first silhouette as well as the last silhouette was chosen by participants as being unhealthy and unattractive for men. However even within that choice there was a stronger leaning towards the larger figures as unhealthy than the thinner figures.

**Table-4: Mean and Standard Deviation of figure choices, according to the Body Mass Index of participants (N = 303)**

Category	CBS	IBS	Women Attractive	Men attractive	Men Unattractive	Society's ideal	Healthy	Unhealthy
Underweight	2.72 (.82)	3.20 (.84)	3.27 (.82)	3.41 (1.11)	8.15 (2.09)	3.88 (.96)	4.93 (1.84)	5.46 (3.9)
Normal	3.66 (.84)	3.08 (.73)	2.88 (1.02)	3.04 (1.00)	7.77 (2.57)	3.60 (.89)	4.25 (1.53)	6.34 (3.75)
Over weight	4.52 (.85)	3.19 (.65)	2.61 (.88)	2.94 (.89)	7.81 (2.5)	3.55 (.85)	4.03 (1.56)	6.52 (3.64)
Obese	5.12 (1.07)	3.27 (.86)	2.80 (.98)	2.88 (1.46)	8.34 (1.46)	3.71 (.98)	4.05 (1.26)	7.0 (3.45)
Total	3.68 (1.17)	3.15 (.77)	2.95 (.97)	3.11 (1.02)	7.96 (2.31)	3.69 (.92)	4.39 (1.62)	6.20 (3.78)

## Discussion

### Perceptual dimensions

Analysis of the perceptual dimensions of body image, showed a prevalence of faulty body image among the respondents. More than 23.7% of girls perceived themselves as overweight



and obese while in actuality only 13% were overweight, according to their BMI. Amongst the participants who considered themselves to be fat ( $n = 69$ ), 47.8 % belong to the normal weight category according to their actual BMI. These results agree with the findings of Story et al [18], where they have reported prevalence of faulty body images among adolescent girls. Similarly, almost half of the girls assigned to the underweight category according to their BMI, perceived themselves to be of normal weight. Thus, while 28.8 % of the sample was actually underweight only 18 % of them perceived themselves to be so. Such a belief on the part of the girls may hinder any effort to gain a desirable and healthy weight, essential for their nutritional status and developmental health. These results also reinforce the idea that thinness to the extent of being underweight is being accepted as normal and desirable by adolescent girls. On the other spectrum, an interesting finding was that, several girls who were assigned to the obese category according to their BMI (5.2%) did not perceive themselves as obese (2.9 %). These results may indicate a need to present to the researcher, a desirable picture of self, in the light of the emphasis that is being placed by the society on leaner silhouettes as more desirable and successful. Obesity as a social term has several negative social associations leading to bias, stereotype and discrimination against the obese. The potential reason, for this under reporting then could be the reluctance to admit that they are obese and to put a label on their weight.

These descriptions point out to the fact that girls have insecurities about their bodies and these insecurities may affect their ability to make realistic objective evaluation of their bodies. These observations are consistent with previous research findings, where results showed that even when girls are slim, they still consider themselves heavy or heavier than they appear [19]. In fact, Thompson and Thompson (1986) reported that the average global distortion level is 25% above accuracy [7]. These findings support the contention that a woman's body image satisfaction is dependent on subjective feelings and perceptions about



their bodies rather than on objective weight. There have been very few studies that have examined body size perception in non-clinical samples in India. The results from the current study add to the body of knowledge about these processes in the general population.

### **Attitudinal dimensions**

Desirable body size may be characterised by collective social representation of appropriate and attractive shapes for men and girls [20]. Historically, in non-western societies girls' heaviness was associated with positive attributes of wealth, fertility and femininity. It was expected that societies that were influenced by these cultural norms would be relatively unaffected by the risks of BID. However, it appears that attitudes are rapidly changing and there is an increasing incidence of BID in non-western societies as well.

### ***Current vs. Ideal figure ratings***

The participants in the present study revealed a strong preference for the lower weight silhouettes as best depicting their desired weight. Figures-2 and 3 were the two figures around which ideal figure selections were most common. 18.8 % of the girls chose # 2 as their ideal while 53.4% chose #3 as their desired body shape (Table 3). Both these results are of concern, especially the percentage of girls choosing # 2, because it suggests that these girls harbour a strong appreciation for an extremely thin female body. It also indicates that these girls believe that a body size which is actually suggestive of under nutrition depicts attractiveness.

Additionally, more than half of the girls, regardless of the BMI group they belonged to choose # 3 as their desired figure, indicating a growing trend among young girls to consider slim figures as attractive and desirable. This finding is consistent with previous research that the most frequently selected ideal figure was approximately figure # 3 [21]. This figure probably reflects the current ideal of the female body advocated in the Indian society, an



ideal close to the one advocated in the west. This preference for thinness has previously been reported by Shroff and Thompson [22], that pursuit for thinness, so prevalent among teenage girls from the U.S is also widespread among Indian girls.

Grogan [4] also noted that there is an increased desire for muscularity and toned body image since the beginning of the 21<sup>st</sup> century, indicating a change in girls' perceptions of the ideal female body image over time. Ascertaining the social meanings connected to slimness over the years, Susan Bordo shows, how at the starting of the end of the last century, excess flesh (for men and women) came to be associated with low morals, reflecting personal ineptitude or lack of will [23]. This has sustained into the 2000s, where the exterior appearance of the body is seen as a denotation of personal order or disorder. Slenderness embodies being in control and a firm toned body is seen as depicting achievement. Bordo notes that the stress to have a toned body is still profound in 2000s, even though cultural discourses suggest that diversity in body shapes is a positive thing [23].

A finding of particular concern in the quantitative survey was that amongst the participants who desired to be thinner, almost 58.32 % of the participants belonged to the normal weight category according to their BMI. These findings lead us to believe that ideal of "thin as beautiful" may have been internalised in this group of young girls. Tiggeman and Rothblum [21] have proposed that prominence given to weight and physique has ensued in mass dissatisfaction with body shape in female population. Body dissatisfaction experienced to such an extent could prompt young girls to pursue an unrealistic body size by adopting potentially harmful weight reducing behaviours that could have an effect on their nutritional status and development. Jane Ogden (1992) contends that these are especially critical when used by normal weight individuals who just "feel fat" [24].

However, results in the current study also show that majority of underweight girls (80 %) desired to increase their weight and body size, to achieve what they considered to be ideal



size. This result is inconsistent with the findings of western studies where irrespective of their weight status, girls desired to lose weight [25]. This may suggest that although Indian girls desire to be slim, extreme thinness may not be the desired ideal.

Over 75% of the girls in the present study were dissatisfied with their bodies (Fig 2). Internalisation of cultural definitions of what an ideal (beautiful, desirable) woman should look like, has led many girls to consider their normal adult bodies as unacceptable. The fact that such a vast number of girls, belonging to different body types chose the same range of figures as desirable indicates how we have narrowed the definition of beauty.

#### *Figures attractive to men and women self-ideal and current body shape*

Consistent with earlier literature on European American girls [26], Indian women also thought that their own body size was larger than the size they believed men would find most attractive. Women may have these beliefs because they consider that men would not like to date girls who are of larger size. The findings in the current study were supported by a study in which Sue Lamb and colleagues found that girls tend to believe that men preferred much thinner body shapes than the men themselves actually chose [27].

The results in the present study showed that, across the BMI groups, there was no difference, in the selection of figures girls thought men would find most attractive. The second, third and fourth figures were most frequently chosen as attractive to men. This was the same range of figures that were chosen as their own ideal and desirable by the participants. In the comparison of self-ideal and figures attractive to men, previous research has been inconclusive. Some research reported that self-ideal was thinner than what was considered attractive to men [26]; some findings suggest that the ideal was larger than what was considered attractive to men [28]. In other research no difference was found [29]. The means calculated for the sample in the present study also showed a very small difference of 0.4 of a figure size, between the figure selections. This difference is probably more statistical than



practical. Perhaps girls who view their ideal figure and attractive to men figure as the same are viewing their bodies in a manner that seeks approval from the male gaze. They may be having a deep internalisation of the cultural message -that men seek attractive girls and this ideal attractiveness is determined by men.

#### *Girls' self-ideal and figure attractive to other girls*

The results of the present study show that peer ideal was estimated as lower than girls' ideals. This result was noted in all BMI groups, other than the underweight group where peer ideal was higher than self-ideal, results consistent with previous research [28]. Studies of European American female peer groups, suggest that girls perceive thinness to be important to their peers [30]. The fact that the Indian girls in the current sample, showed the same pattern may indicate that they share the same values of body image as those in the European American samples.

The results suggest that girls exaggerate the desire for thinness held by their peers. This result is expected as the social pressure that girls face to be thin is tremendous. However, what stands out as interesting is the discrepancy between what girls' desire for themselves as an ideal body and what they think other girls would consider as ideal. Why did the girls in this study not choose the same figure for self-ideal and peer ideal?

One of the explanations for this comes from an evaluation of media images of thin figures that are projected as attractive and desirable. Constant and consistent messages of "thin as beautiful", lead girls to believe that other girls are also striving for a very thin ideal. While assessing their own bodies however, they may accept that to achieve that level of "thinness" they would have to engage in drastic weight loss attempts. Their perception of the ideal figure is influenced not only by what society projects as ideal, but also their own self-assessment of what is probably possible for them. Thus the figure selected as self-ideal is larger than what is perceived as peer ideal. These results also point towards another pressure



that girls face. Since they believe that all other girls, are also striving for a thinner ideal body, not pursuing this ideal and not attempting to lose weight makes them feel abnormal.

***What should be the ideal figure size in society?***

The vast majority of girls in all groups chose an ideal figure (society) that was larger than the figures chosen as self-ideal, peer ideal or one than men found attractive. This suggests that although girls pick up a thinner ideal for self, they also recognise the negative aspect of such an ideal and would prefer that society's ideal should be one that represents a normal body size. Girls in the normal weight group chose the society's ideal, as a figure that was much closer to their current body size rather than their desired body shape. This suggests that girls experience intense pressure to achieve a smaller body shape, while if given a choice they would prefer to remain their normal size, only if society would accept it. It is quite likely that adolescents realise that they are subjecting themselves to irrational pressure of conforming to societal norms of beauty but yet they feel powerless to stop themselves in the face of so much social pressure. It would be interesting to know whether girls believe they have the capability to change the ideal and what they think would be the way to do it. Future research could ask them these questions to explore whether they think they have any influence over this process.

***Girls' self-ideal and figures considered healthy***

The results of the current study threw up some interesting findings and also indicated the severity of the problem. Across all weight groups, healthy ideal was estimated as much larger than the self-ideal. Interestingly even though the sample chose the middle silhouette (4.39) as the healthiest figure, the choice of the figure they desired was way below at 3.15. This suggests that despite a conscious acknowledgement of a middle size figure as healthy, the young girls harboured a desire to have a slimmer figure. This desire was most likely a result





of choosing physical attractiveness over health. Such a distorted preoccupation about the body has become a major concern since it has led to several unhealthy dietary practices.

Also, an analysis of figures considered unattractive by men and those considered unhealthy, revealed a choice of larger figures in the range of #5 to #9 rather than the very thin figures of #1 and #2. These findings emphasise a strong societal prejudice towards slimness as beautiful and healthy and overweight as unattractive and unhealthy.

Thus, we notice a clear shift in body image ideals amongst Indian girls. Heaviness in women which was viewed as attractive and desirable in the '60s is today considered to be undesirable, unhealthy and unattractive. Earlier Indian beauty ideals presumed a well fed figure with rounded curves [12] and such preferences remained strong till as recently as the 1980s and 1990s. However in the current scenario, several urban girls are accepting the notion of thinness as the ideal body [31]. Latha et al also reported that 86 % of female adolescent students desired to be slim. Phrases such as 'size zero' and 'skinny' have become a part of everyday discourse [32]. The number of gymnasiums has grown exponentially, there is an easy availability of diet foods in our markets and we are constantly being bombarded with numerous advertisements about weight loss programs, all indicating a growing focus on thinness being considered as the ideal. In this regard, several authors have observed that the idealised images of male and female attractiveness, shown in print and film media have become increasingly similar in the western and non-western societies. These images appear to be promoting change in traditional standards of feminine attractiveness [33]. Body image dissatisfaction is considered to be a normative discontent among adolescent girls in Western society [34]. Unlike previous understanding that body image issues are limited to the western population, the results of the current study show that it is a pervasive concern for the adolescent girls in the Indian context as well.



One of the limitations of the current study is that, all primary data has been collected from the city of Pune, and this information may be applicable only in urban areas, while the concept of body image may be significantly different in rural areas. Studies exploring the concept of body image in girls in rural areas can be undertaken and cross comparisons can be performed with the present study. It may be insightful to study women from various parts of India, to determine if the degree and frequency of body image dissatisfaction and factors influencing this dissatisfaction is similar to that found in this sample. Further, gender wise and age wise studies can be explored in the context of body image.

To conclude, the current data contributes to the knowledge about the attitudinal and perceptual dimensions of body image in Indian adolescent girls, thus furthering the understanding of how they feel about their body and their underlying motivations to engage in restrictive health practices to lose weight. It is important to consider the implications of the current research for informing prevention programs for eating disorders. Counsellors should be aware that Indian women may also be struggling with body image issues. This may be especially important in adolescent girls because they are developmentally at an age where these issues occur. Prevention programs could attempt to build a culture that provides a balance between healthy eating and activity with acceptance of different body shapes and sizes.

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