Exploring the Relationship Between Play Activities and Motor Development in Preschoolers Using PDMS-2: An Observational Study

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KEYWORDS

PDMS -2, Motor development, Play activities, Pre-schoolers

ABSTRACT

Background
Motor development in early childhood is fundamental to overall growth and later physical competence. Play activities—including toy availability, child playtime, and parent- child interaction—are key contributors to motor skill acquisition. With increasing screen time among preschoolers, it is essential to assess how play activities impact their motor development.

Objective
This study aimed to explore the relationship between various play-related factors and motor development in preschool children. Specifically, it examined the influence of toy availability, playtime duration, and parent-child interaction on motor skills. Additionally, it sought to identify age-related trends in these factors and their impact on motor development.

Method
A cross-sectional study was conducted among 578 preschool-aged children (3–5 years) in Belagavi, India. Participants were selected through randomized preschool recruitment. Parents provided data on play-related factors through structured interviews. Motor development was assessed using the Peabody Developmental Motor Scales-2 (PDMS-2), and statistical analysis included independent t-tests, two-way ANOVA, and regression analysis.

Results
Toy availability and playtime significantly influenced motor development in four-year-olds ($p = 0.0435$) and five-year-olds ($p = 0.0030$). Parent-child interaction was most impactful in three-year-olds ($p = 0.0475$). Regression analysis identified caregiver influence and the father's occupation as key predictors in younger children, while the mother's age and residence duration affected older children's motor scores.

Conclusion
The study highlights the importance of play factors in fostering early motor development. While toy availability and playtime positively influence motor skills, the effect of parent-child interaction is more pronounced in younger children. These factors tend to improve with age but plateau beyond a certain developmental stage.

Introduction

Engaging in physical activity during kindergarten is essential to a child's educational journey. Engaging in physical activities and body-based experiences is vital for developing self-understanding and different modes of expression, and it encourages people to lead more physically active lives.[1] Children enhance their physical fitness by participating in play activities. When they engage in play with peers, they improve their muscular and movement skills. [2] Long-term research has demonstrated that engaging in physical activity and enhancing motor skills offers numerous important health and developmental benefits.[3]

A study conducted in Romania in 2019 found that children in preschool tended to engage less with their surroundings and peers. They also experienced instances of feeling overwhelmed or scared by the behavior of other children in the group, such as making loud noises during play.[4] Also, the study

found that pre-schoolers who have been active in the game had improved motor development and hold on the language. [5] The studies conducted in India have found a positive correlation between motor development and play activities. Also, the recent evidence among preschoolers in India (South India) has found that children spent 80 to 85% of their time to screen activities instead of engaging in play.[6] These studies were done in adolescent and infant populations. However, there is limited evidence of the same in preschoolers. Thus, the need arises to evaluate the correlation between play activities and motor development in preschoolers.

METHOD

The present observational study was conducted in urban areas of Belagavi, Karnataka, India, from October 2024 to January 2025. The KLE Institute of Physiotherapy's Institutional Ethical Committee granted ethical approval (KLEKIPT/IEC/2022-23/SI.No:836, dated 1st October 2024) and registered with the Clinical Trials Registry – India (CTRI/2024/12/078009) before the recruitment of the participants. The list of preschools in Belagavi was collected from the block division office, Belagavi. Preschools were then randomly selected through the random number table. Permission was obtained from the school authorities to conduct the study. Participants were screened based on inclusion and exclusion criteria. The inclusion criteria were participants in the age group 3-5 years of age with both genders, deemed as typically developing by the pediatrician. Participants absent in the school during the time of recruitment or parents unwilling to provide consent were excluded. The eligible participants, parents and Class teachers were explained regarding the study and the participants were provided with the written informed consent to voluntarily participate in the study, to publish the result findings. Questionnaire consisting of information on Play materials and child and parent time interaction with the toys was interviewed to the parents by the principal investigator following the instructions in the manual, the PDMS-2 was administered.[7] by experienced Physical therapist. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to summarize the collected data. Raw scores from each subtest, which were documented in the examiner's record booklets, were converted into age equivalents, percentiles, and standard scores. The standard scores from the gross and fine motor subscales were combined to calculate the Gross Motor Quotient (GMQ), Fine Motor Quotient (FMQ), and Total Motor Quotient (TMQ). An independent sample t-test was performed for the Correlation between motor development (PDMS-2 TMQ) and availability of play materials and child and parent time interaction across three distinct age groups of children. The data was analyzed using a two-way analysis of variance for the Correlation between motor development (PDMS-2 TMQ) and availability of play materials and child and parent time interaction among different age group. regression analysis was applied to determine the relationship between several independent variables and the dependent variable PDMS-2 TMQ Scores. The p value < 0.05 was considered as significant. Data were analyzed by using the SPSS software (SPSS Inc.; Chicago, IL) version 29.0.10.

RESULTS

The numbers of participants at each stage of study is depicted in figure 1. In this study, 578 participants were recruited. The major findings from Table 1 highlight key demographic characteristics of study participants across three age groups. Gestational age remains consistent across all groups, averaging around 38.6 weeks, while birth weights are also similar, ranging from 2.97 kg to 3.04 kg. Expected age progression is observed, with mean ages increasing from 40.84 months in Group I to 65.24 months in Group III. Correspondingly, present weight and height also show an increasing trend, with Group I averaging 11.98 kg and 91.59 cm, while Group III averages 15.23 kg and 104.96 cm. Gender distribution varies across groups, with more females in Group I (56.70%), more males in Group II (53.74%), and a balanced ratio in Group III. Birth order differences are notable, as Group I consists

entirely of first-borns, whereas Groups II and III include an increasing proportion of second-born children. The distribution of caregivers is relatively balanced, with no dominant category across groups. Family characteristics indicate that most families reside in type 2 housing, particularly in Group II (56.54%), and have lived in their current home for four to five years, with Group II showing the highest percentage at four years (27.10%). Parental demographics reveal that mothers' ages range from an average of 28.58 years in Group I to 33.37 years in Group III, while fathers' ages increase from 31.53 years to 35.12 years. Educational attainment varies across groups, with a notable proportion of parents achieving higher education. Fathers in Group III are more likely to hold higher-level occupations. Overall, these demographic findings provide a comprehensive understanding of the study population, offering crucial context for further research analysis. Table 2 presents an analysis of the correlation between motor development and various play activities across three age groups of children. The key factors examined include toy availability, child time, and parent-child interaction, each categorized as fair or poor. The results indicate that most children in all groups had fair access to toys, with mean motor development scores being relatively high. However, a significant difference was observed only in Group II ($p = 0.0435$), where children with fair toy availability had higher motor development scores than those with fair access. Regarding child time, motor development scores were generally higher in the fair category, but only a significant difference was observed in Group III ($p = 0.0030$), indicating that greater playtime positively impacted motor development in this age range. For parent-child interaction, motor development scores were generally higher in the fair category. Significant difference was found in Group I ($p = 0.0475$), where children with fair interaction had slightly higher motor development scores, while Groups II and III showed no significant differences. These findings suggest that the relationship between motor development and play activities varies across age groups, with certain factors playing a more significant role at specific developmental stages. Table 3 presents a comparative analysis of various activities across three age groups, highlighting significant differences in toy availability, child time, and parent-child interaction. The results indicate that as children grow older, these factors improve, particularly between Group I (36-47 months) and the older groups. Toy availability, child time, and parent-child interaction all tend to increase as children get older. Specifically, children in the youngest age group (Group I) had significantly lower toy availability compared to both the middle (Group II) and oldest (Group III) groups ($p = 0.0159$ and $p = 0.0289$, respectively). However, toy availability appeared to level off after 48 months, as there was no significant difference between Group II and Group III ($p = 0.9979$). A similar pattern was observed for child time and parent-child interaction. The youngest children (Group I) experienced significantly less child time than both Group II ($p = 0.0149$) and Group III ($p = 0.0279$). Likewise, parent-child interaction was significantly lower in Group I compared to Group II ($p = 0.0160$) and Group III ($p = 0.0290$). In both cases, there was no significant difference between the two older groups (Group II and Group III; $p = 0.9980$ and $p = 0.9979$, respectively), indicating that these measures plateaued after a certain age. These findings suggest that while younger children experience more limitations in these areas, improvements occur as they grow, particularly between the youngest and middle age groups, before stabilizing in the older stages. The regression analysis provides insight into the relationship between several independent variables and the dependent variable PDMS-2 TMQ Scores is represented in Table 4. In group I the variable Main Care Giver (Coefficient of -1.221, p-value of 0.0188) and Father Occupation (coefficient: -0.879, p-value: 0.0001) have a significant negative effect on TMQ, suggesting that Caregivers have a meaningful influence on the outcome and changes in father's occupation are highly predictive of changes in TMQ. while other variables show no substantial impact. In group II, none of the variables significantly predict TMQ scores. In Group III Mother Age (Coefficient: 0.25, p-value: 0.04) and Number of Years Living in the House (Coefficient: 0.35, p-value: 0.01) are the only significant predictors of TMQ, with older mothers contributing to higher

TMQ and longer residence leading to lower TMQ. Other variables in the model do not show statistically significant relationships.

Discussion

The results of the current study indicate that the availability of toys, child time, and parent-child interaction play significant roles in early motor development. The present study found that Children with fair toy availability generally exhibited higher motor development scores, with a particularly significant effect observed in four-year-olds. Similarly, increased playtime was associated with enhanced motor development, showing a notable impact in five-year-olds. Regarding parent-child interaction, a significant influence was found only in younger children, specifically three-year-olds. The statistical significance observed in certain comparisons highlights the importance of these factors in fostering motor skills during early childhood development. These findings align with previous research that emphasizes the role of a stimulating home environment in supporting children's developmental trajectories.

Availability of Toys

The study found that children with fair toy availability had higher motor development scores compared to those with poor access. Research has consistently shown that access to play materials contributes positively to motor development. [8] For instance, a study in South India found that the absence of play materials like pop-up toys and floating toys was associated with lower motor development scores.[9] A randomized controlled trial showed that introducing age-appropriate toys at an early stage greatly enhanced motor development in high-risk infants, leading to significant improvements in both gross and fine motor skills.[9]

Statistical analysis from the present study revealed that toy availability improved as children aged. indicating an age-related improvement in toy availability. However, the comparison between 4 and 5 year old children did not show a significant difference, suggesting that toy availability stabilizes in older age groups. Prior research supports this notion, emphasizing that toys are designed to cater to specific developmental stages, from infancy to pre-adolescence, aiding in motor, cognitive, and social development.[10] Additionally, as children grow, the complexity and variety of toys increase, leading to more engaging play experiences that align with their evolving interests and capabilities .[10] Nevertheless, socioeconomic disparities can impact children's access to diverse and high-quality toys, which may subsequently influence developmental opportunities.[11]

Child Time

The study found that greater playtime positively impacted motor development in the examined age range. Previous research has indicated that children's play is influenced by their developmental stage and the types of toys they engage with.[12]Age-appropriate toys enhance engagement, but their utilization is moderated by toy characteristics and design across different age groups.[13] Regarding child time, the findings reflected that playtime increased as children age. However, after a certain age (between 4 and 5 year old) children the increase in playtime plateaus. Studies indicate that as children age, their ability to judge and manage time improves significantly, with notable advancements around age eight, when they develop more refined reasoning skills .[13] Younger children struggle with time judgments due to limited attentional capacities, but their precision in time perception improves with age .[14] Moreover, in India, there has been a notable increase in children's learning time, with a corresponding decrease in work time, influenced by demographic factors and transitions into schooling .[15] These factors could contribute to the observed increase in child playtime and its impact on motor development.

Quality of Parent-Child Interaction

The present study found that children with fair parent-child interaction had slightly higher motor development scores. Prior research has established that the quality of parent-child interaction is linked to better developmental outcomes.[16]For instance, parent-child activities such as reading have been positively associated with gross motor skills in infants and toddlers .[17] Additionally, parental knowledge and engagement in play activities enhance motor development, underscoring the importance of informed and active parenting .[18]

Findings from the present study indicate that younger children experience less parent-child interaction compared to older age groups. However, in the later age group the quality of parent-child interaction stabilizes. Research suggests that parental beliefs about play significantly influence children's engagement in play activities, which in turn can enhance their developmental outcomes.[19] Moreover, high-intensity attachment relationships can develop through brief but focused interactions, such as 15-minute co-play sessions, challenging the notion that extended time together is necessary for strong parental bonds .[20] Furthermore, parental play stimulation has been shown to be crucial for fostering both social and linguistic development during early childhood, as it provides children with opportunities to explore their environment, communicate, and interact with others.[21] As children grow, parental engagement tends to shift towards more focused interactions, with research indicating that mothers typically spend more time with younger children .[22] This supports the idea that while parent-child interaction levels may stabilize, their nature evolves as children age. Despite its valuable contributions, one limitation of the current research is its focus on (Belagavi, India) which may restrict the applicability of the results to more diverse populations with varying socio-cultural and economic contexts.Second, the study primarily relied on parent-reported data regarding play materials and interactions, which may be subject to recall bias and social desirability bias.

Research examining the link between play and motor skills in Indian preschoolers remains limited, making our study a unique contribution, filling a significant research gap. The use of a validated motor assessment tool (PDMS-2) enhances the reliability of the findings. The study also included a relatively large sample size (N=512), improving the robustness and statistical power of the results. Additionally, by examining three distinct age groups, the study provides insights into developmental trends and plateau effects, contributing to a deeper understanding of how play factors evolve with age. Future research should consider a longitudinal approach to establish causal relationships between play activities and motor development. Intervention-based studies focusing on parental education programs and structured play interventions could also be beneficial in assessing their effectiveness in improving motor skills among preschoolers.

The study's findings have several practical implications for educators, parents, and policymakers. Given the positive association between toy availability, playtime, and motor development, early childhood programs should emphasize providing age-appropriate play materials and encouraging active engagement in play. Parental involvement in play activities should be promoted through awareness campaigns and parenting workshops to enhance interactive play quality. Policymakers should consider integrating structured play sessions into preschool curricula to ensure that all children, regardless of socioeconomic background, receive opportunities for motor skill development. Furthermore, efforts should be made to limit excessive screen time among preschoolers and encourage more active forms of play to support overall physical development.

Conclusion

Toy availability, child playtime, and parent-child interaction are key factors in promoting early motor development, as shown by the current study. These factors tend to improve with age, particularly when comparing younger children to their older counterparts, though they appear to stabilize beyond a certain developmental stage. The study aligns with existing literature emphasizing the role of a supportive home environment in enhancing children's motor skills. Future research should further

explore the impact of socioeconomic disparities on access to play resources and parental involvement, as these factors may mediate developmental outcomes.

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TABLES

Table 1: Demographic characteristics related to the children, their family and parents in the study [n= 578]

Characteristics of the Child	**Group – I (N = 194)**	**Group –II (N = 214)**	**Group – III (N = 170)**
Gestation (Weeks)	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
	38.608 ± 1.08	38.63 ± 1.13	38.7 ± 1.13
Age (Months)	40.835 ± 3.22	53.56 ± 3.45	65.24 ± 3.84
Birth Weight (kgs)	3.01 ± 0.56	2.97 ± 0.56	3.04 ± 0.58
Present Weight (kgs)	11.98 ± 0.60	13.77 ± 0.75	15.23 ± 0.81
Height (Cms)	91.59 ± 2.38	98.67 ± 2.09	104.96 ± 2.04
	N (%)	**N (%)**	**N (%)**
Gender			
Male	84 (43.30)	115 (53.74)	88 (48.24)
Female	110 (56.70)	99 (46.26)	82 (48.24)
Birth Order			
1st	194 (100.0)	113 (52.80)	73 (42.94)
2nd	-	101 (47.20)	97 (57.06)
Main Care Giver			
Mother	71 (36.60)	72 (33.64)	57 (33.53)
Father	55 (28.35)	67 (31.31)	58 (34.12)
Grandparents	68 (35.05)	75 (35.05)	55 (32.35)
Characteristics of the family			
Father's Income			
> 41430	29 (14.95)	33 (15.42)	1. 14.12)
20715-41429	22 (11.34)	28 (13.08)	1. 8.24)
15536-20714	32 (16.49)	26 (12.15)	1. 20.59)
10357-15535	30 (15.46)	40 (18.69)	21 (12.35)
6214-10356	26 (13.40)	28 (13.08)	24 (14.12)
2092-6213	26 (13.40)	25 (11.68)	23 (13.53)
<2091	29 (14.95)	34 (15.89)	29 (17.06)
Housing Type			
Independent	93 (47.94)	93 (43.46)	93 (54.71)
Apartment	101 (52.06)	121 (56.54)	77 (45.29)

Number of years leaving in the Same house						
1	41 (21.13)		37 (17.29)		28 (16.47)	
2	42 (21.65)		37 (17.29)		32 (18.82)	
3	32 (16.49)		44 (20.56)		31 (18.24)	
4	37 (19.07)		58 (27.10)		42 (24.71)	
5	42 (21.65)		38 (17.76)		37 (21.76)	
Number of Adults						
1	38 (19.59)		38 (17.76)		40 (23.53)	
2	32 (16.49)		53 (24.77)		30 (17.65)	
3	44 (22.68)		48 (22.43)		32 (18.82)	
4	47 (24.23)		38 (17.76)		1. 22.35)	
>5	33 (17.01)		37 (17.29)		30 (17.65)	
Characteristics of the Parents						
	Mother (Mean ± SD)	**Father (Mean ± SD)**	**Mother (Mean ± SD)**	**Father (Mean ± SD)**	**Mother (Mean ± SD)**	**Father (Mean ± SD)**
Age (years)	28.58 ± 1.11	31.53 ± 1.68	31.0 ± 2.13	33.23 ± 1.92	33.37 ± 1.95	35.12 ± 2.08
	Mother n (%)	**Father n(%)**	**Mother n (%)**	**Father n(%)**	**Mother n (%)**	**Father n(%)**
Education						
Primary 0-7th Class	36 (18.56)	45 (23.20)	41 (19.16)	42 (19.63)	36 (21.18)	24 (14.12)
Secondary 8-10th	33 (17.01)	39 (20.10)	43 (20.09)	46 (21.50)	35 (20.59)	28 (16.47)
Pre-University 11-12th /Diploma	56 (28.87)	26 (13.40)	48 (22.43)	51 (23.83)	32 (18.82)	33 (19.41)
Graduation	26 (13.40)	45 (23.20)	45 (21.03)	42 (19.63)	32 (18.82)	45 (26.47)
Post graduation	43 (22.16)	39 (20.10)	37 (17.29)	33 (15.42)	35 (20.59)	40 (23.53)
Occupation						
Profession	26 (13.40)	26 (13.40)	19 (8.88)	25 (11.68)	17 (10.0)	31 (18.24)
Semi Profession	16 (8.25)	25 (12.89)	25 (11.68)	34 (15.89)	30 (17.65)	20 (11.76)
Clerical, Shop owner	21 (10.82)	23 (11.86)	20 (9.35)	36 (16.82)	18 (10.59)	21 (12.35)
Skilled worker	28 (14.43)	42 (21.65)	14 (6.54)	35 (16.36)	32 (18.82)	28 (16.47)

Semi Skilled worker	17 (8.76)	24 (12.37)	25 (11.68)	27 (12.62)	18 (10.59)	21 (12.35)
Unskilled worker	35 (18.04)	22 (11.34)	20 (9.35)	26 (12.15)	20 (11.76)	28 (16.47)
Unemployed	51 (26.29)	32 (16.49)	91 (42.52)	31 (14.49)	35 (20.59)	21 (12.35)

Group – I: Age 36-47 months, Group – II: Age 48-59 months, Group – III: Age 60-72 months, SD: Standard Deviation, Kgs: Kilograms, Cms: Centimeters

Table 2: Correlation between motor development (PDMS-2 TMQ) and availability of play materials and child and parent time interaction across three distinct age groups of children.

Activity	**Statistical Summary**	**Group – I (N = 194)**	**Group –II (N = 214)**	**Group – III (N = 170)**
Availability of Toys				
Fair	N (Mean±SD)	141 (93.57 ± 6.14)	194 (98.40 ± 6.71)	148 (95.25 ± 6.39)
Poor	N (Mean±SD)	53 (93.26 ± 6.18)	20 (94.98 ± 7.17)	22 (95.31 ± 6.24)
	P-value[1]	0.7548	0.0435	0.9672
Child Time				
Fair	N (Mean±SD)	102 (93.25 ± 6.58)	76 (95.53 ± 7.63)	61 (97.18 ± 4.51)
Poor	N (Mean±SD)	92 (93.75 ± 5.64)	138 (95.17 ± 6.95)	109 (94.19 ± 6.97)
	P-value[1]	0.5726	0.7266	0.0030
Parent Child Interaction				
Fair	N (Mean±SD)	35 (95.54 ± 6.09)	92 (95.70 ± 6.97)	79 (95.92 ± 5.86)
Poor	N (Mean±SD)	159 (93.25 ± 6.42)	122 (94.77 ± 7.46)	91 (94.50 ± 6.83)
	P-value[1]	0.0475	0.3496	0.1464

Group – I: Age 36-47 months, Group – II: Age 48-59 months, Group – III: Age 60-72 months, SD: Standard Deviation, P-value was obtained by using Independent Sample t-test, P-value <0.05 is significant

Table 3: Correlation between motor development (PDMS-2 TMQ) and availability of play materials and child and parent time interaction among different age group

Activity	Statistical Summary	Group – I (N = 194)	Group –II (N = 214)	Group – III (N = 170)	I Vs II P-value	I Vs III P-value	II Vs III P-value
Availability of Toys							
Fair	N (Mean±SD)	141 (93.57 ± 6.14)	194 (98.40 ± 6.71)	148 (95.25 ± 6.39)	0.02*	0.03*	1.00
Poor	N (Mean±SD)	53 (93.26 ± 6.18)	20 (94.98 ± 7.17)	22 (95.31 ± 6.24)			
Child Time							
Fair	N (Mean±SD)	102 (93.25 ± 6.58)	76 (95.53 ± 7.63)	61 (97.18 ± 4.51)	0.01*	0.03*	1.00
Poor	N (Mean±SD)	92 (93.75 ± 5.64)	138 (95.17 ± 6.95)	109 (94.19 ± 6.97)			
Parent Child Interaction							
Fair	N (Mean±SD)	35 (95.54 ± 6.09)	92 (95.70 ± 6.970	79 (95.92 ± 5.86)	0.02*	0.03*	1.00
Poor	n Mean±SD	159 (93.25 ± 6.42)	122 (94.77 ± 7.46)	91 (94.50 ± 6.83)			

Group – I: Age 36-47 months, Group – II: Age 48-59 months, Group – III: Age 60-72 months, SD: Standard Deviation, P-value was obtained by using Two-Way Analysis of Variance, P-value <0.05 is significant

Table 4: Regression analysis between PDMS-2 TMQ Scores and demographic characteristics across different age groups of children

Variables	PDMS-2 Total Motor Quotients								
	Group I			Group II			Group III		
	Coefficients		P-value	Coefficients		P-value	Coefficients		P-value
	B	SE		B	SE		B	SE	
Gender	-0.17	0.89	0.85	-0.28	1.04	0.79	-0.54	0.99	0.58
Main Care Giver	-1.22	0.52	0.02*	-0.59	0.63	0.35	0.05	0.61	0.94
Father's Age	0.09	0.27	0.73	-0.11	0.27	0.69	-0.21	0.24	0.37
Father Education	0.19	0.30	0.51	-0.68	0.38	0.07	-0.29	0.36	0.42
Father Occupation	-0.88	0.22	0.00*	0.22	0.26	0.40	-0.26	0.25	0.30
Father Income	0.33	0.23	0.15	0.35	0.26	0.17	0.18	0.25	0.48
Mother's Age	0.02	0.40	0.96	-0.35	0.23	0.14	0.51	0.25	0.04*
Mother Education	0.55	0.32	0.09	0.22	0.38	0.56	-0.02	0.34	0.95

Mother Occupation	-0.19	0.18	0.29	0.14	0.20	0.49	0.17	0.21	0.41
Housing Type	0.18	0.89	0.84	-0.72	1.01	0.47	-0.49	0.98	0.62
Number of Years Living in the house	0.02	0.31	0.96	0.18	0.36	0.63	-0.97	0.35	0.01*
Family Type	-0.01	0.90	1.00	1.47	1.27	0.25	-1.20	0.98	0.22

Dependent variable: PDMS-2 TMQ Scores, Group – I: Age 36-47(months), Group – II: Age 48-59(months), Group – III: Age 60-72(months),B: Beta value, SE: Standard Error, * P-value <0.05 is significant

Figure 1: Numbers of participants at each stage of study