Article

Infrastructure for Delivery of Integrated Child Development Services and Uptake of Pre-school Education Services: Insights from Palghar, India

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Abstract

The Integrated Child Development Services (ICDS) is a flagship programme of the Government of India and is delivered through a vast network of *Anganwadi* Centres (AWCs)—Courtyard Shelters—across rural and urban areas of the country. The ICDS is, however, affected by low coverage of various ICDS services, in general, and preschool education (PSE) services, in particular. This article aims to understand whether status of AWC infrastructure can have an effect on enhancing the coverage of PSE component. The article has twofold objectives: (a) to develop an AWC infrastructure index (AII), which can be applied to support programmatic monitoring and evaluation by ICDS and (b) to comprehend the association of AII with attendance and uptake of PSE services.

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Based on descriptive and econometric analysis of the AWC infrastructure data from Palghar (Maharashtra, India), it is demonstrated that better infrastructure is associated with higher PSE service coverage. The article concludes by highlighting the relevance of investing in AWC infrastructure, refurbishments and quality improvements to expand ICDS service coverage, particularly for the PSE services.

Keywords

ICDS, pre-school education, Palghar, assets index, anganwadi infrastructure, nutrition

Introduction

Launched on 2 October 1975, the Integrated Child Development Services (ICDS) scheme of India—also referred to as the *Anganwadi* Services Scheme—is one of the world's largest programmes for early childhood care and development. The scheme is designed as a response to the fundamental challenges of child development in terms of (a) cognitive development through preschool non-formal education and (b) physical growth by liberating childhood from the vicious cycle of malnutrition, morbidity, reduced cognitive capacity and mortality. The ICDS has the broad objective of strengthening the foundation for psychological, physical and social development of children through nutrition support, counselling and cognitive development services (MWCD, 2019). The scheme is particularly designed to deliver six important services to children (0–6 years) as well as pregnant and lactating mothers as follows: (a) supplementary nutrition, (b) non-formal preschool education (PSE), (c) nutrition and health education, (d) immunisation, (e) health check-ups and (f) referral services.

The ICDS services are delivered through a vast network of *Anganwadi* Centres (AWCs)—Courtyard Shelters—across rural and urban areas of the country. As per the annual report of the Ministry of Women and Child Development (2019), ICDS has 1.37 million operational AWCs, covering 87.5 million beneficiary, viz. children (6 months to 6 years), pregnant women and lactating mothers. ICDS has a specific focus on PSE, and in 2018–2019, it covered a total of 30.2 million children (3–6 years) under the programme. As such, in 2019, the estimated population of 3–6-year children in India was 69.4 million (UNDESA, 2020), thus implying an ICDS coverage of 43.5% of the total eligible beneficiaries. Independent surveys like the National Family Health Survey (2015–2016) estimate a similar coverage (38.2%) for PSE services (IIPS & ICF, 2017; Rajpal et al., 2020). Such low coverage of preschool services is a deterrent in child development in a developing economy with widespread burden of poverty and income deprivations.

Studies have identified various reasons for such low uptake of ICDS AWC services, in general, and PSE services, in particular. This includes aspects such as inadequate training and capacity building of Anganwadi Centre Workers (AWWs), their incentive structures, budgets and implementation of nutrition support services (Avula et al., 2015), for instance, the issues that pertain to geographical

and ministerial convergence, especially in the domain of early childcare and education (Mishra, 2020). Notwithstanding these concerns, poor AWC infrastructure is also identified to play an important role in programme coverage and participation. In 2015, the *NITI Aayog* (premier policy think tank of the Government of India) had conducted a rapid assessment of AWCs across 19 states and union territories (UTs) and found that 41% of the AWCs had either a shortage of space or were unsuitable, whereas 13.7% did not have safe drinking water facilities. Previously, in 2011, the Planning Commission of India had also noted that the AWCs lack adequate infrastructure to deliver the designated services.

Studies have also found considerable interstate and intrastate heterogeneities and gaps in AWC infrastructure, including drinking water and toilet facilities (Joe & Subramanyam, 2020). For instance, in the state of Andhra Pradesh, Helena et al. (2014) find that only 29% of the AWCs have toilets, 20% have regular water supply and 50% have a separate kitchen. Gill et al. (2017) review the infrastructure of 400 AWCs in Amritsar, Punjab, and find that only 53% of the AWCs have regular water supply. These basic amenities along with essential items, such as Information, Education and Communication (IEC) posters, growth monitoring–related equipment, weighing scales, PSE learning resources are necessary for ensuring quality service delivery. Lack of space within the premises for conducting outdoor and indoor activities like games and songs also adversely affects the delivery of non-formal PSE. The problem has long persisted as even some of the earlier audits by the Office of the Comptroller and Auditor General noted that half of the AWCs in India had inadequate space for outdoor and indoor activities and lacked separate space for storage of materials. Similarly, the number of cooking and serving utensils was considered inadequate in AWCs (CAG, 2013). Over the years, such deficiencies have disrupted the delivery of PSE component, which is at the core of the ICDS programme (Azim Premji Foundation, 2013).

A good non-formal PSE is not only instrumental for motor and cognitive development of children that can have long-term human capital impact, but it also holds intrinsic relevance for shaping attitudes, values and behaviour in children. However, there is limited attention paid to developing the PSE component, which is the weakest point of the programme (Kaul, 2002). In particular, a few studies have shown that poor infrastructure contributes to poor attendance and coverage (Malik et al., 2015). Given the dismal state of infrastructure, in recent years, efforts are noted to improve the AWC infrastructure and strengthen PSE services. In particular, the Prime Minister's Overarching Scheme for Health and Nutrition in India (POSHAN Abhiyaan) has provided momentum to ICDS programme and has also inspired various national and international organisations to improve AWC services.

In this regard, it is important to understand whether improvements in AWC infrastructure can have an effect on enhancing the coverage of PSE component. This article is motivated with this concern and has two specific objectives of: (a) developing an AWC infrastructure index (AII) to help support policies and programmes to undertake a summary assessment of AWC infrastructure for monitoring and evaluation and (b) comprehending the association of AII with PSE component uptake and demonstrate its relevance for investing in AWC

infrastructure, refurbishments and quality improvements. The analysis is based on the microdata from 150 AWCs from the Palghar district of Maharashtra.

Data and Methods

The analysis is based on the data from 150 AWCs spread across 8 administrative blocks of the Palghar district in Maharashtra. The AWCs were selected based on a stratified random sample with blocks serving as a unit for stratification. Data were collected in 2018 by the field agency IQVIA Consulting and Information and Services Private Limited. Ethical clearance was obtained from Sigma Institutional Review Board for the data collection protocols. Information on various aspects of AWC items and amenities was collected by trained field investigators using a pre-designed and pretested pro forma. For the development of AII, 28 items related to AWC items and amenities are selected and categorised into five domains, viz. AWC surroundings, AWC building quality, AWC basic amenities, AWC PSE amenities and growth monitoring equipment (Supplementary Table S1). The domain-specific items are listed as follows: (a) AWC surroundings: clean and hygienic; ponds, rivers or dangerous places nearby; and sources of pollution (air, water, noise, land) nearby. (b) AWC building quality: type of building (pucca building: concrete roof and brick wall); condition of building (new construction); exterior wall colouring; compound wall or fence; outdoor play material; type of flooring (cement or tiles); and cemented interior wall. (c) Amenities: electricity connection; electric fan; pump or tap water; functional toilet; small mats (carpets); shelfs or racks; low wooden chair and table; growth chart and registers; and adequate storage space. (d) PSE: toys; educational material; PSE kit; availability of posters; and availability of PSE learning modules. (e) Growth monitoring equipment: weighing machine (adults); Salter weighing scale for infants; mid-upper arm circumference (MUAC) tapes; and stadiometer or height measuring tape.

Information on the number of child beneficiaries (3–6 years) in the AWC catchment area and the number attending the PSE component were recorded from the AWC Registers in 2018 for the months of April, May and June. PSE attendance was defined as the percentage of children (3–6 years) attending the AWC vis-à-vis the total child beneficiaries for the AWC area. The PSE attendance was calculated separately for each month. Information on location of AWC as predominantly rural or tribal geographical area was also collected.

Anganwadi Centre Infrastructure Index

The AII is constructed for AWC assets and amenities using two approaches: (a) principal component analysis (PCA) method of variance-based dimension reduction technique (Filmer & Pritchett, 2001) and (b) a composite mean-gap normative-based asset index (Mishra & Joe, 2020). The former method is widely employed for construction of asset indices (Rutstein & Johnson, 2004), whereas the latter allows for inequality analysis at individual and group levels. However, a

high degree of concordance between these two indices is expected. The PCA-based asset and amenity index of the AWC can be sensitive to variable specification; hence, it is tested for internal coherence and robustness. Since all the asset and amenity information is dichotomised (availability: yes = 1 and no = 0), the PCA-generated weights—defined as scoring factor divided by standard deviation (SD)—for the items can be interpreted as the marginal change in the asset index value, which is attributable to change in the availability of the concerned asset or amenity. The PCA-based asset scores are then categorised into five quintiles whereby AWCs in the lowest quintile have relatively poor assets and amenities, whereas those in the highest quintile have better availability of these various assets and amenities.

The composite mean-gap-based asset index is defined as follows:

$$\text{Mean gap asset index}_j = \frac{\sum_{i=1}^{n} a_{ij}\left(1-\mu_i\right)}{\sum_{i=1}^{n}\left(1-\mu_i\right)}$$

where a_i is the ith asset or amenity feature of the jth AWC. If the jth AWC has the asset or amenity feature, then a_i assumes a value of 1 (0 otherwise). Here, μ_i is the mean value of the ith asset or amenities in the given sample of AWCs. It may be noted that the asset or amenity feature (a_i) is weighted using ($1 - \mu_i$) based on the population-level unavailability of the particular asset or amenity. In other words, an AWC having an asset or amenity, which is owned by fewer AWCs (like electricity connection), receives greater weights than an asset owned by most (like weighing instrument for adults).

Further, we apply the Gini coefficient at the individual AWC level (G) and at the generalised entropy (GE-2) index on the composite asset index scores to understand overall as well as between- and within-block inequalities in AWC assets and amenities (Cowell, 1980). The G_I ranges between 0 and 1, with a higher value denoting greater inequality in distribution of asset and amenities across AWCs. The GE(2) defines equality (GE(2) = 0) as a case when asset scores of each AWC match with the mean of asset index score. Higher values denote higher inequalities in the distribution of AWC assets and amenities.

Econometric Analysis

The availability of various AWC assets and amenities may depend on AWC stakeholders (the *anganwadi* worker, the community and the department). While the AWCs are managed by the Department of Women and Child Development, difficulties in securing these assets and amenities may also vary by latent characteristics of the AWC worker or the community or the local office of the department. In this regard, it is useful to understand how each asset or amenity or the group of all these items is associated with such latent features of the stakeholders. The item response theory (IRT) models are used to decipher these associations (StataCorp, 2015). An item characteristic curve (ICC) is plotted to

describe the probability that an AWC 'succeeds' in possessing a given asset or amenity. The probability of success in owning the item increases with the better efforts from the stakeholders (anganwadi worker, community and the line department). The probability of success, however, is a function of both the item properties and the latent traits of the stakeholders. For analytical purposes, this latent trait is denoted by θ. The item properties are parameters commonly known as difficulty and discrimination, which can be estimated using IRT models. The difficulty parameter (β) represents the location of the asset or amenity on the ability scale. The slope of the ICC is used to comprehend the second item parameter of discrimination (α) and informs about the pace of change in probability of success vis-à-vis the item difficulty. Items with large discrimination value (αs) have high correlation between the item-specific probability of success and the underlying latent trait. Items with large discrimination parameter, thus, can effectively distinguish between varying levels of latent trait. Based on a likelihood ratio test for choice of parameterisation (StataCorp, 2015), a two-parameter logistic model is used to evaluate the association between the latent trait of the stakeholders and the items related to infrastructure intended to measure the trait. The model was used to identify the items on the basis of their availability.

Finally, the association between AII and PSE attendance is ascertained using univariate analysis and multivariate analysis. The univariate analysis describes the trend and patterns in availability of different assets and amenities in the sample of AWCs. The association with attendance was also examined using two-way scatter plots. Further, the association of asset index (both PCA and composite score–based approaches) with the PSE attendance was examined using multilevel linear regression models with attendance as the dependent variable and AII values and quintile from the two approaches as the key explanatory variables. The model also adjusts for location type of AWC (rural/tribal). We also estimate the variance partition coefficient (VPC) to understand between-block variations in attendance (Leckie & Charlton, 2013). All the analyses are performed using Stata 15.0.

Results

AWC items such as mats and carpets (94%), MUAC tapes (96%), weighing machine for adults (93%), and growth charts and registers (94%) were commonly available, whereas assets and amenities such as electricity connection (15%), painted exteriors (16%), compound wall and fencing (16%), tap water for drinking (22%) or toys for children (26%) were available in fewer AWCs (Table 1). A total of 41% of the AWCs had a functional toilet, and 30% were functioning from a pucca building with concrete/cemented roof, walls and floor. A total of 76% of the AWCs had educational and learning materials (like blocks, cards etc.), and 66% of the AWCs had low wooden chairs and tables as well as shelves and racks for storage purposes. However, only 41% of the AWCs had PSE kits, and 40% had Salter weighing scale for infants. Most of the AWCs were located in relatively

Table 1. Descriptive Statistics of Assets and Amenities for Selected AWCs, Palghar, 2018.

AWC Assets and Amenities	*N*	Mean	SD
MUAC tapes	150	0.96	0.20
Growth charts/registers	150	0.94	0.24
Mats and small carpets	150	0.94	0.24
Weighing machine for adults	150	0.93	0.26
Plastered interior wall	150	0.91	0.28
Stadiometer	150	0.91	0.29
Cemented or tiled floor	150	0.82	0.39
New building	150	0.80	0.40
Free from dangerous places (ponds, lakes, etc.)	150	0.79	0.41
Educational material (blocks, etc.)	150	0.76	0.43
Posters	150	0.69	0.47
Pollution-free vicinity	150	0.68	0.47
Low wooden chairs and tables	150	0.66	0.48
Shelves and racks for storage	150	0.66	0.48
Clean and hygienic surroundings	150	0.64	0.48
Adequate storage space for toys, etc.	150	0.59	0.49
AWW modules	150	0.47	0.50
Outdoor play material	150	0.43	0.50
Functional toilet	150	0.41	0.49
Salter weighing scale for infants	150	0.41	0.49
PSE kit	150	0.40	0.49
Pucca building	150	0.30	0.46
Toys	150	0.26	0.44
Tap water for drinking	150	0.22	0.42
Painted exterior wall	150	0.19	0.39
Compound wall or fencing	150	0.16	0.37
Electricity connection	150	0.15	0.36
Electronic fan	150	0.13	0.34

Source: The authors.

pollution-free locations (68%), had clean and hygienic surroundings (64%) and had no dangerous places like ponds or lakes (79%) in their vicinity.

The information on AWC assets and amenities can provide valuable insights regarding AWCs' preparedness for service delivery and the key gaps and variations in its distribution. Two approaches are used to comprehend the status of assets and amenities across AWCs. The PCA-based approach determines the weights for each of the 28 items and provides a scheme of ranking the AWCs based on the availability of the specific asset or amenities (Filmer & Pritchett, 2001). Summary statistics related to the first principal component using these 28 indicators is described as follows (Table 2). The AII score has a mean of 0 and SD of 2.15. The first principal component explains 16.5% of the covariance. The Cronbach's alpha for the 28 items is 0.77. Since all the 28 items are dichotomised and used as binary variable (0 or 1), the weights (defined as scoring factor/SD) can be interpreted as the marginal change in asset index score, which can be attributed to a change in the availability of the concerned asset item. For instance, having a weighing machine for adults, stadiometers, low wooden chairs and tables, as well as shelves and racks for storage provides a greater weightage to the AWC index, whereas having functional toilet, tap water for drinking, electricity connection, outdoor play material and Salter weighing scale for infants has lower weights. The mean value of various assets for lowest and highest AII quintiles is presented in Table 2. There are major gaps in the availability of various assets and amenities between the lowest (Q1) and the highest (Q5) quintiles (Table 2). For instance, shelves or racks are available with only 10% of the AWCs in the Q1, whereas 93% of the AWCs in Q5 possess these items. Functional toilet is available with only 20% of the AWCs in Q1, whereas 50% AWCs from Q5 have functional toilets.

Table 2. Summary Statistics for Variables Entering the Computation of First Principal Component and Mean of Assets and Amenities for Lowest and Highest Quintile AWCs, Palghar, 2018.

AWC Assets and Amenities	Weights	Mean (Q1)	Mean (Q5)
Weighing machine for adults	0.94	0.67	1.00
Plastered interior wall	0.81	0.67	1.00
Stadiometer	0.77	0.67	1.00
Shelves and racks for storage	0.73	0.10	0.93
Low wooden chairs and tables	0.66	0.17	1.00
Mats	0.64	0.83	1.00
Growth charts/registers	0.64	0.83	1.00
Adequate storage space for toys, etc.	0.62	0.17	1.00
Clean and hygienic surroundings	0.58	0.17	1.00

(*Table 2 continued*)

(*Table 2 continued*)

AWC Assets and Amenities	Weights	Mean (Q1)	Mean (Q5)
Posters	0.53	0.30	0.93
New building	0.51	0.53	0.97
Educational material (blocks, etc.)	0.49	0.50	1.00
MUAC tapes	0.49	0.87	1.00
Painted exterior wall	0.46	0.00	0.57
Free from dangerous places (ponds, lakes, etc.)	0.41	0.47	0.90
AWW modules	0.40	0.13	0.83
Pollution-free vicinity	0.37	0.40	1.00
Toys	0.35	0.07	0.63
Cemented or tiled floor	0.34	0.63	1.00
PSE kit	0.32	0.10	0.50
Compound wall or fencing	0.29	0.03	0.33
Electricity connection	0.24	0.07	0.23
Electronic fan	0.22	0.03	0.20
Tap water	0.20	0.10	0.40
Functional toilet	0.17	0.20	0.50
Pucca building	0.13	0.20	0.30
Outdoor play material	0.11	0.30	0.50
Salter weighing scale for infants	0.11	0.30	0.37

Source: The authors.

Note: The percentage of covariance explained by the first principal component is 16.5%. The first and the second eigenvalue are 4.60 and 2.68, respectively. Weights are computed as Scoring Factor/SD. Cronbach's alpha is estimated to be 0.77.

The AII is also reviewed for internal coherence and robustness of the PCA approach. For this purpose, three alternative indices are constructed using subset of these 28 variables to infer regarding the sensitivity in quintile formation. The first alternative model for sensitivity check excludes three variables related to AWC surroundings (free from dangerous places (ponds, lakes, etc.), pollution-free vicinity, clean and hygienic surroundings). The second model excludes two variables (electricity connection and electric fan), whereas the third model excludes two variables (tap water for drinking and functional toilet). All these models return a high value for Cronbach's alpha (0.76–0.78), and the first principal

component explains 16.9%–17.6% of the covariance. The Spearman and Pearson correlation coefficients for alternative models are in the range of 0.951–0.998. The AII index quintile categorisation performs well across sensitivity specifications, and in none of the cases, AWCs from the lowest AII quintile get classified in third, fourth or fifth quintile (supplementary Table S1).

A second approach for AII construction based on the mean-gap-based composite score is also applied. The mean AII score based on this approach is 0.40 with variations between the various blocks (from 0.33 to 0.53) of the district (Table 3). The Gini coefficient for overall mean-gap-based AII score is 0.22 The GE(2) index is estimated to be 0.08 and its decomposition suggests that between-block differences in mean-gap score account for 14% of the total GE(2) inequality. There is a high degree of concordance in the AII-constructed two approaches—PCA approach and the mean-gap-based approach (supplementary Table S2).

IRT-based single- and two-parameter logistic models are applied to understand differences in latent traits critical for ownership of various items by the AWCs. The ICC, based on a single-parameter-based logistic model for the 28 items, suggests that owning MUAC tapes is the least difficult item, whereas owning an electric fan is the most difficult item (Figure 1). In other words, for having an electricity connection and electronic fan requires greater ability of the AWC stakeholders (worker, community or department). The varying ICC slopes indicate

Table 3. Summary Statistics for Variables Entering the Computation of First Principal Component and Mean of Assets and Amenities for Lowest and Highest Quintile AWCs, Palghar, 2018.

Blocks	% Share in Total AWC	Mean AWC Index Score	% Share in Total AWC Index Score	GE(2) Index	Gini Coefficient
Dahanu	11.3	0.33	9.3%	0.15	0.31
Jawahar	20.0	0.43	21.5%	0.06	0.20
Mokhada	8.0	0.33	6.6%	0.09	0.23
Palghar I	12.7	0.53	16.7%	0.03	0.15
Talasari	3.3	0.38	3.2%	0.00	0.04
Vada	10.0	0.41	10.2%	0.03	0.13
Vasai	6.7	0.40	6.6%	0.05	0.16
Vikramgad	28.0	0.37	25.9%	0.08	0.23
All	100.0	0.40	100.0%	0.08	0.22

Source: The authors.

Note: The Generalised Entropy (2) index is decomposed for between-blocks and within-blocks inequalities in AWC index score. The between-blocks and within-blocks GE(2) inequality decomposition values are 0.011 (14%) and 0.068 (86%), respectively. The total GE(2) inequality index value is 0.079 (100%).

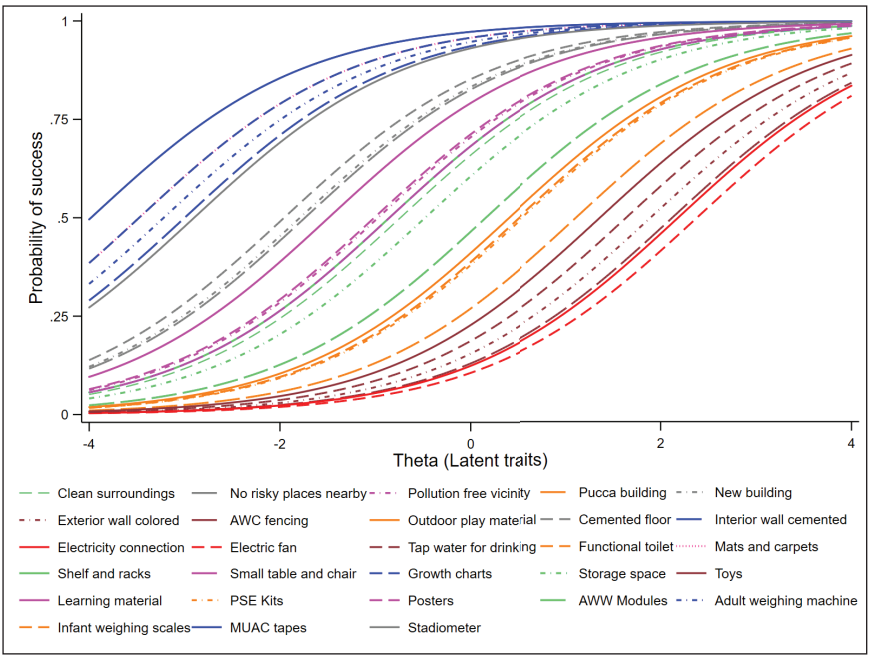

Figure 1. Item Characteristics Curve (ICC) Based on One-parameter Logistic Model for AWC Assets and Amenities Along the Latent Trait Continuum, Palghar 2018.

Source: The authors.

that item discrimination varies across AWCs and can be associated with low and high levels of the AWC stakeholder traits. Accordingly, a two-parameter logistic model is used to estimate the discrimination and difficulty parameters associated with each of the 28 AWC items (Table 4). A likelihood ratio test (χ^2 (27) = 125.9; *p*-value = 0.000) is also conducted that finds the two-parameter model superior to the single-parameter model. Items such as shelves and racks, weighing machine for adults, and low wooden chairs and tables have high and statistically significant discrimination parameters of 3.22, 2.28 and 2.04, respectively. In other words, despite having similar underlying difficulty, any two AWCs with differing ability of the stakeholders will lead to significant variations in the ownership of these items. Further, the item difficulty parameter suggests that securing electricity connection (3.61) and compound wall and fencing (3.24) and tap water for drinking (3.14) has high difficulty level. Having MUAC tapes (−4.55), growth charts (−2.84) and mats (−2.80), etc., have least difficulty associated with them.

Finally, the status of AWC infrastructure as captured through the AII is associated with the PSE attendance during the months of April, May and June 2018 across AWCs. On a monthly basis, AWCs with better physical location (clean and hygienic surroundings, away from dangerous places [lakes etc.] and pollution-free vicinity) have over 80% attendance for PSE component (Table 5). Availability of toys and learning material, as well as adequate storage space for toys, shelves and racks for storage, low wooden chairs and tables also have higher

attendance levels. The mean PSE attendance across AWCs shares a positive association with AII quintiles (Figure 2). The PSE attendance in AWCs in the lowest AII quintile is about 65%–67% during April, May and June, whereas the same reaches a higher level of 79%–83% for the AWCs in highest AII quintile. The association is further examined using both ordinary least squares approach and multilevel random-effects model to account for inter-block variations in AWCs. The AII index, based on the mean-gap asset index score, finds a positive and significant association under both the approaches (Table 6, Supplementary Table S3 and S4). A 0.01 unit change in the mean-gap-based AII score is associated with a 0.4% point increase in PSE attendance in both the models (models I and III). The AII index based on the PCA approach also finds significant infrastructure-related gradient in AWC attendance. For instance, compared to AWCs in the lowest quintile of the AII, in both the models, AWCs in the highest quintile have 23% higher PSE attendance (models II and IV). These models are also adjusted for location of the AWCs (rural or tribal) as well as the month of attendance. The tribal area AWCs have a marginally higher attendance, but the significance is inconsistent. Similarly, PSE attendance in June is marginally higher than April and May, but the effects are significant only in the random-effects model. Besides, the block-level VPC of the random-effects model are low (2.6% and 5.2% in models II and IV, respectively) and suggests that there are no major between-block variations in PSE attendance.

Table 4. Item Discrimination and Difficulty Parameters Based on Two-parameter Logistic Model for AWC Assets and Amenities, Palghar 2018.

	Item Discrimination Parameter		Item Difficulty Parameter	
AWC Assets and Amenities	Coefficient	95% CI	Coefficient	95% CI
MUAC tapes	0.75	[−0.21; 1.72]	−4.55*	[−9.69; 0.58]
Growth charts/registers	1.16**	[0.24; 2.07]	−2.84***	[−4.55; −1.14]
Mats	1.18**	[0.27; 2.10]	−2.80***	[−4.44; −1.17]
Cemented or tiled floor	0.66**	[0.13; 1.20]	−2.48***	[−4.31; −0.65]
Stadiometer	1.68***	[0.66; 2.70]	−1.91***	[−2.66; −1.17]
Plastered interior wall	1.80***	[0.71; 2.89]	−1.91***	[−2.62; −1.20]
Weighing machine for adults	2.28***	[0.77; 3.80]	−1.84***	[−2.46; −1.22]
Free from dangerous places	0.85***	[0.31; 1.39]	−1.81***	[−2.84; −0.78]
New building	1.06***	[0.47; 1.65]	−1.59***	[−2.34; −0.83]

(*Table 4 continued*)

(*Table 4 continued*)

	Item Discrimination Parameter		Item Difficulty Parameter	
AWC Assets and Amenities	Coefficient	95% CI	Coefficient	95% CI
Educational material (blocks, etc.)	1.13***	[0.53; 1.73]	−1.27***	[−1.87; −0.67]
Pollution-free vicinity	0.99***	[0.43; 1.54]	−0.92***	[−1.47; −0.37]
Posters	1.34***	[0.71; 1.98]	−0.78***	[−1.19; −0.38]
Low wooden chairs and tables	2.04***	[1.17; 2.91]	−0.54***	[−0.83; −0.26]
Clean and hygienic surroundings	1.85***	[1.00; 2.71]	−0.49***	[−0.79; −0.19]
Shelves and racks for storage	3.22***	[1.58; 4.85]	−0.48***	[−0.72; −0.23]
Adequate storage space for toys, etc.	2.39***	[1.31; 3.46]	−0.29**	[−0.55; −0.04]
AWW modules	0.87***	[0.39; 1.35]	0.14	[−0.29; 0.58]
PSE kit	0.57**	[0.13; 1.00]	0.77*	[−0.03; 1.57]
Functional toilet	0.27	[−0.10; 0.65]	−1.40	[−0.82; 3.62]
Toys	0.77***	[0.26; 1.28]	1.53***	[0.56; 2.50]
Painted exterior wall	1.19***	[0.49; 1.90]	1.55***	[0.82; 2.28]
Salter weighing scale for infants	0.16	[−0.21; 0.53]	2.38	[−3.48; 8.24]
Outdoor play material	0.11	[−0.25; 0.48]	2.58	[−6.07; 11.23]
Tap water	0.42*	[−0.05; 0.89]	3.14*	[−0.27; 6.55]
Compound wall or fencing	0.54*	[0.00; 1.09]	3.24**	[0.20; 6.28]
Electricity connection	0.50*	[−0.07; 1.06]	3.61*	[−0.26; 7.48]
Electronic fan	0.46	[−0.14; 1.06]	4.24	[−0.97; 9.45]
Pucca building	0.18	[−0.22; 0.59]	4.65	[−5.63; 14.93]

Source: The authors.

Note: ***, ** and * Denote significance at the 1%, 5% and 10% levels, respectively.

Likelihood ratio test (chi-square (27) = 125.9***) favours the two-parameter model instead of one-parameter model and allows for separate discriminator parameter and difficulty parameters for each item.

Table 5. Mean Attendance During April, May and June by AWC assets and Amenities Availability Status of the AWCs, Palghar, 2018.

	April		May		June	
AWC Assets and Amenities	Yes	No	Yes	No	Yes	No
Clean and hygienic surroundings	82	69	80	69	83	71

(*Table 5 continued*)

(*Table 5 continued*)

Free from dangerous places (ponds, lakes, etc.)	82	60	81	59	83	62
Pollution-free vicinity	80	71	79	70	82	73
Pucca building	80	76	79	75	81	78
New building	78	72	78	68	81	72
Painted exterior wall	81	76	81	75	82	78
Compound wall or fencing	81	76	81	75	85	78
Outdoor play material	78	77	76	76	78	79
Cemented or tiled floor	75	88	73	89	77	89
Plastered interior wall	77	84	76	84	78	85
Electricity connection	81	77	76	76	79	79
Electronic fan	81	77	76	76	79	79
Tap water	79	77	76	76	77	80
Functional toilet	76	78	74	78	77	80
Mats	77	75	77	72	79	80
Shelves and racks for storage	85	63	83	63	85	66
Low wooden chairs and tables	82	67	82	66	85	68
Growth charts/registers	78	66	77	67	80	71
Adequate storage space for toys, etc.	84	68	82	68	85	70
Toys	83	75	80	75	82	78
Educational material (blocks, etc.)	80	68	79	67	81	72
PSE kit	81	75	80	74	84	76
Posters	81	70	79	71	81	74
AWW modules	82	73	80	73	83	76
Weighing machine for adults	76	87	76	85	78	88
Salter weighing scale for infants	75	78	75	77	77	80
MUAC tapes	77	86	76	85	79	84
Stadiometer	76	86	75	84	78	86

Source: The authors.

Table 6. Econometric Estimates (OLS and random-effects models) for Association of PSE Attendance with AWC Infrastructure Index (both composite score and PCA), Palghar 2018.

Dependent variable: PSE attendance	Ordinary Least Squares (OLS)		Random Effects Model (2-level)	
	Model I	Model II	Model III	Model IV
All Score × 100 (composite)	0.40***		0.41**	
[95% CI]	[0.27; 0.53]		[0.05; 0.77]	
2nd quintile All (PCA)		2.5		1.3
		[−3.5; 8.5]		[−9.6; 9.8]
3rd quintile All (PCA)		19.7***		19.4**
		[13.7; 25.6]		[3.2; 36.3]
4th quintile All (PCA)		22.7***		22.8***
		[16.8; 28.6]		[7.8; 37.0]
5th quintile All (PCA)		14.9***		14.3**
		[8.9; 20.9]		[0.0; 27.6]
Rural AWC	−3.84	−5.8*	−4.76	−5.5
	[−10.62; 2.94]	[−12.3; 0.7]	[−13.23; 3.71]	[−13.8; 2.9]
May	-0.86	−0.9	-0.86	−0.9
	[−5.71; 3.99]	[−5.5; 3.8]	[−2.76; 1.04]	[−2.8; 1.0]
June	2.18	2.2	2.18*	2.2*
	[−2.67; 7.03]	[−2.4; 6.8]	[−0.35; 4.71]	[−0.4; 4.7]
Constant	64.8***	70.5***	64.8***	70.2***
	[55.9; 73.6]	[62.8; 78.2]	[49.2; 80.3]	[56.2; 84.3]
R-squared	0.087	0.179		
VPC			2.6%	5.2%
[95% CI]			[1.0%; 7.0%]	[0.9%; 25.5%]
N	444	444	444	444

Source: The authors.

Note: ***, ** and * Denote significance at the 1%, 5% and 10% levels, respectively.

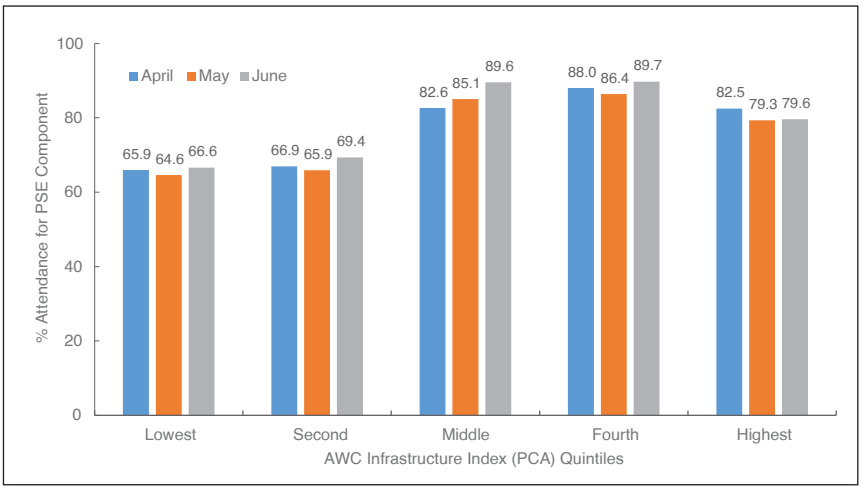

Figure 2. Attendance for Preschool Education Services by AWC Infrastructure Index Quintiles, Palghar 2018.

Source: The authors.

Discussion

The current study focuses on the status of AWC assets and amenities in the Palghar district (Maharashtra, India) and develops an AII to examine its association with coverage and attendance for the PSE component. It is expected that better availability of basic assets and amenities for the AWCs can lead to improvement in service delivery and utilisation of these services, particularly to promote child development. The AII as a concept is found to be relevant for a summary assessment of the AWC assets and amenities. The AII can help support policies and programmes to improve monitoring and evaluation and thereby improve needs assessment of AWCs across ICDS project areas. The AII proposed here comprises of 28 AWC assets and amenities that broadly captures the domains related to AWC physical surroundings, AWC building status and aesthetics, AWC basic amenities, AWC preparedness for PSE and growth monitoring. The AII index was constructed using two alternative approaches, viz. PCA and composite mean-gap normative-based asset index (Filmer & Pritchett, 2001; Mishra & Joe, 2020). There was a high degree of concordance in the AII rankings based on the two approaches. The sensitivity analysis for the PCA-based AII quintiles are internally consistent and provide robust rankings of the AWCs based on their assets' and amenities' ownership status.

The four salient findings of the study are as follows. First, there is a positive association of the status of AWC assets and amenities with attendance for the PSE component. AWCs with better AII ranking had higher attendance for the PSE component. Second, PSE attendance is significantly higher in AWCs with safe physical surroundings. Location of AWCs away from dangerous places (like

ponds or lakes) and with clean and hygienic conditions are important factors that add to the aesthetic value of the AWCs. Third, aspects such as electricity connection, drinking water tap connection, exterior paintings, compound wall and fencing of the AWCs are among the most difficult items to be realised and require greater ability on account of the stakeholders (AWW, community and line department). Fourth, the demand for PSE services is very high in Palghar. The PSE attendance is marginally higher in AWCs from tribal areas than non-tribal rural areas, reflecting greater relevance of the ICDS for the tribal community.

Before discussing these findings, it is worth noting the potential limitations of the analysis. First, the information on AWC assets and amenities was collected based on observations of the trained field investigators. But it is likely that the observations regarding certain indicators, which are likely to have an element of subjectivity, may be biased. For instance, observations related to AWC surroundings being clean and hygienic or pollution-free. Second, the analysis is based on a sample of AWCs from only one district (Palghar) of Maharashtra. Hence, for effective generalisation, it is important to conduct similar assessments across other districts to further ascertain the association between AWC infrastructure and PSE attendance. Third, the study design and data are cross-sectional in nature and do not allow any causal inference regarding the impact of AWC infrastructure on PSE. Fourth, latent factors like ability and interest of the stakeholders (Anganwadi workers [AWWs], local community and line department officials) play an important role in both AWC infrastructure and PSE attendance, but no specific information is available to examine these aspects in detail. However, these limitations are unlikely to alter the main assertion that improvements in AWC infrastructure are associated with higher PSE attendance.

AWC infrastructure is an important area for policy engagement. It is widely observed that water, toilet and electricity facilities are almost non-existent across AWCs in several states of India (Joe & Subramanyam, 2020; Sahoo et al., 2016). The physical environment of the AWCs is also not conducive to promote play learning (Das, 1999). It is usually observed that AWCs operate in a single-room setting. All the AWC activities related to PSE as well as other services are delivered through this single-room set-up. Under such circumstances, interest of children in various play-learning activities like indoor games is hampered due to lack of space as considerable space is also occupied for storing of supplementary materials (Manhas & Qadiri, 2010). Strengthening of service delivery through AWC building provision with adequate space and basic amenities is, therefore, a high priority for ICDS. Systemic support can vary by nature of asset or item. For instance, the IRT-based models show that owning MUAC tapes is the least difficult, whereas having access to electricity connection and electronic fan is the most difficult.

Even after a considerable duration since ICDS programme was launched, such findings on AWC's infrastructure and amenities warrant further research on allied issues (Mishra, 2020). It is imperative from both policy and programme perspectives to identify the underlying factors for such status quo. A clear distinction in terms of interplay of policy-level and programme-level (implementation) factors can shed further light on the subject matter. In this

regard, sanctioning adequate public funds is central to the infrastructural improvements. However, in addition to this, interdepartmental and inter-ministerial convergences are also perhaps important to fill the structural and logistical gaps. Our findings pertaining to the higher difficulty in accessing electricity also reflect upon the issue of interdepartmental convergence. Further, at the ground level, attention needs to be paid to improving governance, and accountability at all administrative and implementation levels, which could be instrumental in enhancing basic amenities such as electricity, toilet and safe drinking water.

While the PSE attendance is responsive to AWC assets and amenities status, it can also show some variations across the year. The data for the PSE attendance for the sample AWCs, here, are collected during April, May and June. The econometric analysis finds that the PSE attendance in June is marginally higher than April and May, but the effects are significant only in the random-effects model. Such an effect is expected because the months of April and May are the peak months during the summer season in Maharashtra. During such a period, a lack of electricity and water connection can discourage attendance as children are likely to be discomforted in heat and may require additional facilities like electronic fans or drinking water provisions (National Productivity Council [NPC], undated). The plight of lack of electricity connection emerges as a matter of policy concern at all levels of the ICDS programme. Studies from various parts of India observe that AWCs mostly rely on natural light as a source of lighting in the AWCs. Even in urban settings like Delhi, it is noted that lack of electricity remains a concern (Malik et al., 2015).

The study found that AWCs with better physical location (clean and hygienic surroundings, away from dangerous places [lakes, etc.] and pollution-free vicinity) have over 80% attendance for PSE components. Similar associations are also noted by other studies, which argue that proper physical infrastructure is critical for smooth functioning of the AWCs (Dwivedi & Nagda, 2013). Good infrastructure ensures that the AWWs and children are provided with the necessary facilities for a proper learning experience. The concept of AII developed, here, thus assumes salience as it takes into account aspects such as physical infrastructure, building, location, type, surroundings, PSE material and aesthetics. The AWC delivers PSE to the community with specific focus on those among the deprived sections of the society and helps develop values and capabilities among children over and above developing their literacy and numeracy skills. Availability and accessibility to a variety of PSE learning materials and facilities are, therefore, important aspects for ICDS monitoring and evaluation. The AII, thus, facilitates quick assessment of various aspects and can encourage policy attention on the deprived AWCs. In fact, studies from different parts of India have noted varying levels of shortage of PSE kits (Chudasama et al., 2015; Dixit, et al., 2010). Its impact is also apparent in the form of reduced engagement by AWWs in PSE component (Dhingra & Sharma, 2011).

In summary, it is useful to briefly highlight the key demands of the AWWs regarding the AWC infrastructure as elicited through the survey. Some of the items demanded or required by most of the AWWs are as follows: electricity connection, building repairs and refurbishments, toilet facility, drinking water

facility, PSE kits and learning materials, uniform for children, kitchen, compound wall and outdoor play area. Provisioning of such items requires greater coordination within the government departments as well as across stakeholders (including the community and various philanthropic or non-governmental organisations). Greater investment by the union and the state governments as well as promotion of community support towards ICDS programme can be effective in fulfilling some of these demands of the AWCs. Regular monitoring and assessment of the infrastructure through indices like the AII can also promote robust competition across stakeholders to improve the physical infrastructure and basic amenities of the AWCs and strengthen delivery of ICDS services for child development.

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