



October 2018

Early Childhood Lead Exposure among Cleveland Kindergarteners by Neighborhood and School Enrollment

Rob Fischer, Ph.D., Stephen Steh, M.A., & Tsui Chan

Key points:

- Having an elevated blood lead level in early childhood is associated with an increased risk of academic and behavioral problems when children become school age.
- Approximately one-quarter of kindergarteners in the Cleveland school district arrive at school with a history of elevated lead according to a blood test.
- There is wide variation by school in the percentage of entering children that have a history of an elevated lead level, reflecting underlying neighborhood differences in lead exposure
- Schools with higher proportions of kindergartners with an elevated lead history may face particular challenges in meeting their educational needs.
- Preventive efforts to reduce childhood lead exposure in neighborhoods would lessen impacts on children and the schools where they enroll

Note: Lead data used in this report come from the Ohio Department of Health. This should not be considered an endorsement of this study or these conclusions by the Ohio Department of Health.

Introduction

Lead is a heavy metal that when ingested by children is known to be a neurotoxin with both short-term and long-term health effects. Cleveland has markedly higher lead exposure among children compared to many other communities. The primary threat of lead exposure to children comes from leaded paint in homes built before 1978 when there is deterioration and lack of maintenance, especially in windows, doors, and porch areas.

Though annual testing has shown a decline in the percentage of Cleveland children under 6 that test positive in a given year (11.6% in 2016), children ever exposed during their early childhood remain at serious risk. The most recent data show that 25% of Cleveland Metropolitan School District kindergarteners have tested at an elevated level of lead at least once prior to age 6. This has implications for these children as they develop and enter kindergarten.

Though there is no known safe level of lead in children's blood, the Centers for Disease Control and Prevention has set the level of 5 micrograms per deciliter ($\mu\text{cg}/\text{dL}$) as a reference level to identify children with lead levels that are much higher than most children's levels. This level is based on the U.S. population of children ages 1-5 years who

are in the highest 2.5% of children when tested for lead in their blood, based on data from the National Health and Nutrition Examination Survey (NHANES). In this report, we apply this threshold in determining whether a child has an elevated blood lead level.

The Impact of Lead

Childhood lead exposure has been linked to a variety of negative health and behavioral outcomes. Lead impacts a child's IQ and cognitive development, executive functioning, and self-control (Canfield, Henderson, Cory-Slechta, Cox, et al., 2003; Chen, Cai, Radcliffe, & Rogan, 2007). Lead has been linked to lower performance on school readiness assessments and early grade proficiency tests (Miranda, Kim, Overstreet Galeano, Paul, et al., 2007). Evidence shows links between lead exposure and negative behaviors in preschool (Liu, Liu, Wang, McCauley, Pinto-Martin, Wang, Yan, & Rogan, 2014; Medelson, Dreyer, Fierman, et al., 1998; Wasserman, Staghezza-Jaramillo, Shrout, Popovac, & Graziano, 1998). In addition, elevated lead is linked to behavior and achievement problems in the primary grades (Braun, Kahn, Froelich, Auinger, & Lanphear, 2006; Chandramouli, Steer, Ellis, & Edmond, 2009; Evens, Hryhorczuk, Lanphear, Rankin, et al., 2015; Zhang, Baker, Tufts, Raymond, et al., 2013).

The prevalence of children with special learning needs stemming from lead exposure in classrooms has an impact on the instructional practices of teachers. To the extent that these children experience developmental delays that put them behind their nonexposed peers, they will require additional instructional supports and time in order to close the gap. Similarly, these children may also display behaviors that make them more challenging to teach. Combined, these two dimensions make these children more likely to be identified for special educational supports and be subject to more in-school disciplinary actions.

Lead exposure in children is highly correlated with the housing quality of the family home and the neighborhood where they reside, along with the poverty rate of the area. Data on Cleveland children show that exposure to distressed housing and neighborhoods is associated with a greater likelihood of lead exposure and lower kindergarten readiness scores (Coulton, Richter, Kim, Fischer & Cho, 2016).

Current Analysis

The present analysis examines the extent to which children arrive at kindergarten in Cleveland schools with a history of elevated lead. The population studied are all children enrolled in kindergarten in the Cleveland Metropolitan School District (CMSD) in three recent years (2014-15, 2015-16, 2016-17), a total of 10,397 children. These school enrollment records were matched to lead testing data from the Ohio Department of Health from 2008-2016. For each child, all lead testing results conducted between the ages of birth and kindergarten entry were accumulated. The two items of interest for this analysis were (1) whether the child had a documented lead test, and (2) whether the children had a confirmed lead test showing an elevated blood lead level (above the standard 5 µcg /dL).

Some children were tested and had a test showing an elevated blood lead level via a capillary test (i.e., finger stick) but these were never confirmed with a more definitive venous blood draw. The lead testing data were tabulated for each of 67 CMSD schools which enrolled kindergarteners during this three-year period. The child’s home address at the time of kindergarten enrollment was used to calculate lead exposure rates by Cleveland neighborhood.

There are several limitations of this analysis. As a cohort of CMSD kindergarteners, these results cannot be generalized to all children born in the City of Cleveland during this period, as some children may leave the district prior to kindergarten and others may enroll in parochial and charter schools. Also, the neighborhood the child lived in at kindergarten entry may not have been the location of the lead exposure since children may have moved several times prior to entering school.

Individual lead testing data is provided to CWRU under a data usage agreement with the Ohio Department of Health from HHLPSS: Healthy Homes and Lead Poisoning Surveillance System. The analysis of these data governed by approved protocols from the CWRU and ODH Institutional Review Boards.

Finding

For the entire population of kindergarten children, 84.0% had at least one documented lead test sometime prior to kindergarten entry. As shown in Figure 1, the majority of tested children (68%) have a documented BLL below the CDC’s reference level of 5µcg/dL. Approximately 15% have a lead value above 5 but below 10µcg/dL and 10% had a lead result above 10µcg/dL. An additional 6% of children had an initial lead test result above 5µcg/dL but the initial result was never confirmed by a venous blood draw. The rest of this report focuses on those 25.7% that had at least one confirmed test result above the 5 µcg/dl threshold.

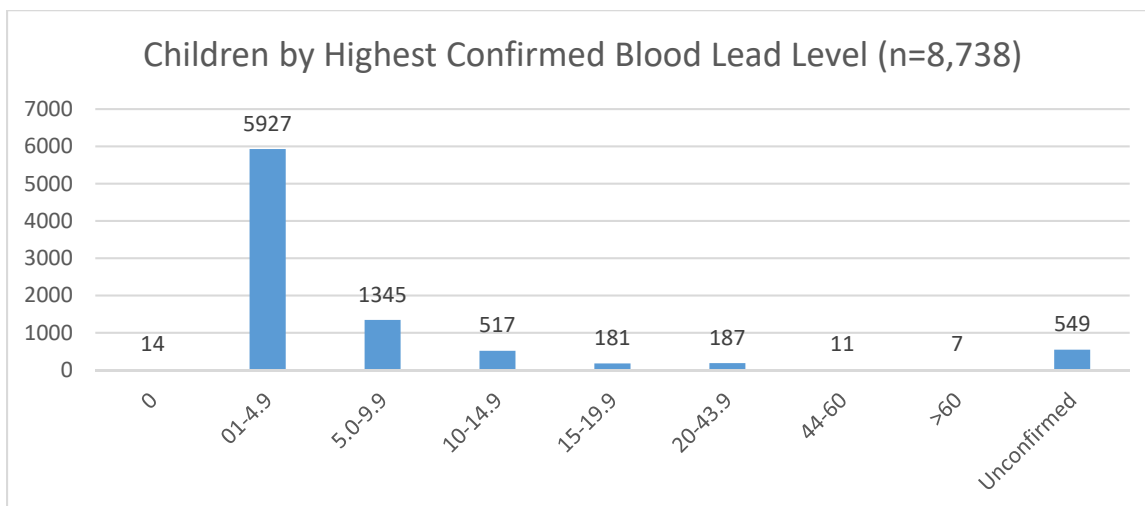


FIGURE 1: Lead Testing Value Among Kindergarteners (All schools)

As shown in Figure 2, among the children with a confirmed EBLL (n=2,248), nearly one-half first had this test result between the ages of 1 and 2 (45%) and 28% had their first elevated test result between the ages of 2 and 3. An additional 22% had a EBLLS between ages 3 and 5. A small percentage of children (3%) had their first EBLL during the first year of life or in the year before turning 6.

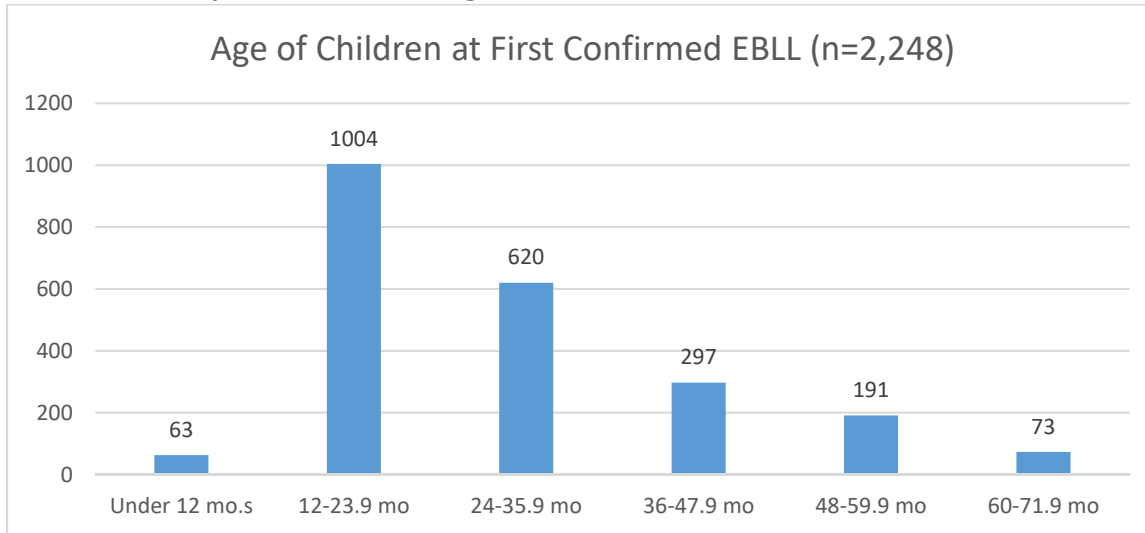


FIGURE 2: Age at EBLL for Children with an EBLL (All schools)

Results by Neighborhood and School

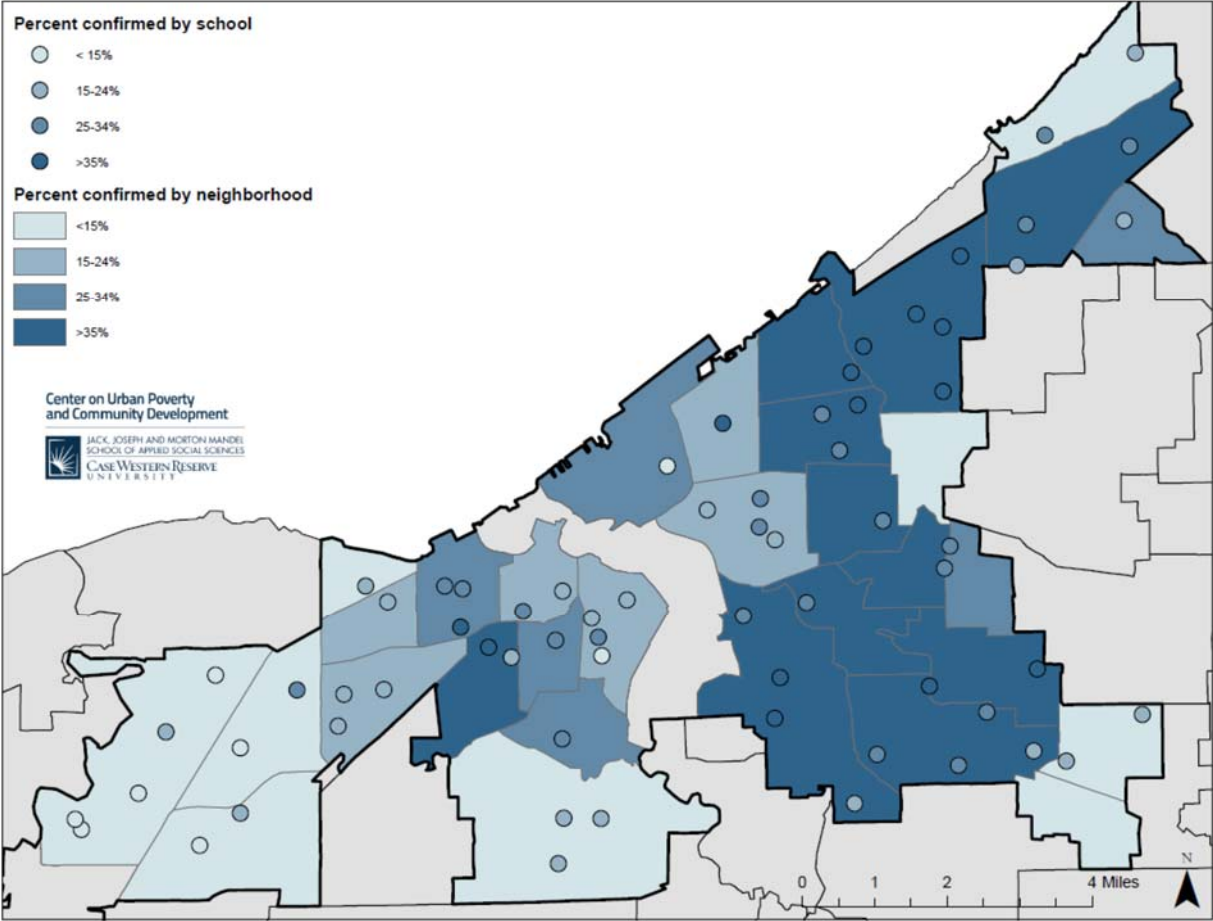
Child lead testing and elevated blood lead levels (EBLL) vary across Cleveland neighborhoods. See Table A for neighborhood-level data based on the residence of children at kindergarten entry. The neighborhoods with the highest proportions of resident kindergarteners who have a history of EBLL are Glenville (40.4%) St. Clair-Superior (36.2%), Buckeye-Woodhill (34.7%), Broadway-Slavic Village (34.6%) on the City’s east side and Stockyards (34.0%) on the west side.

Across the Cleveland schools there is substantial variation in respect to the prior lead testing of children and the frequency of EBLLs. Schools ranged in the percentage of children tested from a high of 95.6% to a low of 54.0%. The range on percent of tested children with EBLL extends from a high of 46.7% to a low of 7.6%. See Table B for proportions tested and with EBLL by Cleveland school.

The schools with the highest proportions of kindergarteners who start school with an elevated blood lead history are geographically concentrated in specific neighborhoods. Of the 10 schools with the highest EBLL rates, 5 are in Glenville, 2 are in Broadway-Slavic Village, and one each in Goodrich-Kirtland Park, Hough, and St. Clair-Superior. Among the 10 schools with the lowest EBLL rates, 4 are in Kamm’s Corners, and one each in Old Brooklyn, Downtown, Jefferson, Tremont, Bellaire-Puritas, and North Shore Collinwood.

Higher EBLL proportions are observable among children on the eastern side of the City and lower rates are seen among children on the western side. See Figure 3. The proportion of kindergarteners with EBLL by schools closely align with the proportions found in the neighborhoods they serve. The influence of families' housing on their children's exposure to lead risk suggests that preventive efforts are best focused on the quality of the housing for families with young children.

FIGURE 1: Map of CMSD Schools with Kindergartens and Lead History Prevalence



Conclusion

This brief highlights the disparity in lead exposure by Cleveland neighborhood and school. Generally, schools with a greater prevalence of children with lead histories are located in proximity to neighborhoods that also have high rates of children with EBLs. The negative impact of early lead exposure on the lives of these children continues to be documented in the medical and research literatures. The spill-over effects of this widespread exposure schools within the educational system should also be considered. Further work is now underway to explore the downstream outcomes for children with EBL in regard to their educational progress, juvenile justice involvement, and earnings in early adulthood. These

results should help illuminate and quantify the later social costs of civic inaction with respect to the prevention of childhood lead exposure.

TABLE A: Early Childhood Lead Testing and Elevated Levels by Cleveland SPA, Kindergarteners Entering School in 2014, 2015, 2016

SPA	2014-2015, 2015-2016 and 2016-2017 School Years		
	# Kindergarteners	% Tested	% Confirmed
Bellaire-Puritas	351	78.6	11.6
Broadway-Slavic Village	500	81.6	34.6
Brooklyn Centre	321	83.2	25.8
Buckeye-Shaker Square	156	86.5	26.7
Buckeye-Woodhill	211	92.9	34.7
Central	571	91.9	23.2
Clark-Fulton	292	84.9	29.0
Collinwood-Nottingham	244	88.5	32.4
Cudell	310	83.9	24.2
Cuyahoga Valley	3	X	X
Detroit Shoreway	324	83.0	27.1
Downtown	75	60.0	26.7
Edgewater	77	77.9	18.3
Euclid-Green	134	87.3	26.5
Fairfax	131	90.8	32.8
Glenville	608	86.7	40.4
Goodrich-Kirtland Pk	52	86.5	24.4
Hopkins	6	X	X
Hough	327	92.4	32.5
Jefferson	480	77.5	16.9
Kamm's	470	72.3	11.8
Kinsman	245	91.0	31.8
Lee-Harvard	188	83.0	17.3
Lee-Seville	87	89.7	19.2
Mount Pleasant	394	86.0	30.7
North Shore Collinwood	282	82.6	19.7
Ohio City	212	86.8	22.8
Old Brooklyn	609	81.3	17.6
St.Clair-Superior	172	86.6	36.2
Stockyards	341	88.0	34.0
Tremont	154	79.9	22.8
Union-Miles	445	87.4	32.1
University	44	84.1	16.2
West Boulevard	678	81.0	23.3
Outside Cleveland	445	80.7	16.2
Unknown neighborhood	458	85.6	23.0

(X) Data are suppressed when the difference between the number of children tested and the number of children found to have elevated blood lead levels is less than 10.

TABLE B: Early Childhood Lead Testing and Elevated Levels by CMSD School, Kindergarteners Entering School in 2014, 2015, 2016

School Name	# Students	% Tested	% Elevated
Adlai Stevenson School	179	82.7	17.6
Alfred Benesch	160	93.1	28.2
Almira	250	88.8	22.1
Andrew J Rickoff	235	84.7	36.2
Anton Grdina	152	92.8	29.1
Artemus Ward	170	80.6	18.3
Benjamin Franklin	224	80.8	16.6
Bolton	146	91.1	33.8
Buhrer	142	90.1	11.7
Campus International School	221	77.8	7.6
Case	143	89.5	39.1
Charles A Mooney School	151	90.7	23.4
Charles Dickens School	154	85.7	31.1
Charles W Eliot School	96	86.5	22.9
Clara E Westropp School	178	74.7	11.3
Clark School	291	84.9	34.4
Daniel E Morgan School	111	90.1	38.0
Denison	140	83.6	25.6
Dike School of Arts Lower Campus	116	91.4	19.8
Douglas MacArthur	142	81.7	9.5
East Clark	103	87.4	32.2
Euclid Park Elementary School	163	81.6	18.8
Franklin D. Roosevelt	171	88.3	45.7
Fullerton School	86	84.9	45.2
Garfield Elementary School	158	81.7	10.9
George Washington Carver	176	90.9	25.6
H Barbara Booker Elementary School	178	86.5	35.7
Hannah Gibbons-Nottingham Elementary School	99	86.9	24.4
Harvey Rice Elementary School	181	91.2	26.1
Iowa-Maple Elementary School	99	90.9	46.7
Joseph M Gallagher School	250	84.0	28.6
Kenneth W Clement	63	92.1	20.7
Louis Agassiz School	141	75.9	22.4
Louisa May Alcott Elementary School	161	76.4	23.6
Luis Munoz Marin School	148	83.1	25.2

School Name	# Students	% Tested	% Elevated
Marion C Seltzer Elementary School	135	82.2	23.4
Marion-Sterling Elementary School	153	92.2	18.4
Mary B Martin School	158	95.6	27.8
Mary M Bethune	96	89.6	40.7
McKinley	74	79.7	27.1
Memorial School	191	79.6	32.9
Michael R. White	76	88.2	38.8
Miles Park School	173	87.9	28.3
Miles School	182	83.0	29.1
Mound Elementary School	161	85.7	39.1
Nathan Hale School	191	83.8	35.6
Newton D Baker School	163	69.3	20.4
Oliver H Perry Elementary School	106	84.9	15.6
Orchard School	159	89.3	25.4
Patrick Henry School	146	89.0	43.9
Paul L Dunbar Elementary School	156	88.5	20.3
Riverside School	151	64.9	11.2
Robert H Jamison School	152	85.5	22.3
Robinson G Jones Elementary School	205	78.1	12.5
Scranton School	152	87.5	20.3
Sunbeam	153	92.2	27.0
Thomas Jefferson International Newcomers Academy	239	54.0	17.8
Tremont Montessori School	287	85.7	21.1
Valley View Elementary School	78	71.8	14.3
Wade Park	136	91.9	29.6
Walton School	119	87.4	31.7
Warner Girls Leadership Academy	158	88.0	18.0
Waverly Elementary School	81	86.4	27.1
Wilbur Wright School	159	76.7	18.9
William C Bryant Elementary School	159	76.7	16.4
Willow School	93	82.8	31.2
Willson School	177	81.4	37.5

All CMSD Kindergarteners 2014-16 10,397 84.0% 25.7%

References

- Braun, J. M., Kahn, R. S., Froehlich, T., Auinger, P., & Lanphear, B. P. (2006). Exposures to environmental toxicants and attention deficit hyperactivity disorder in U.S. children. *Environmental Health Perspectives, 114*(2), 1904-1909.
- Canfield, R. L., Henderson, C. R., Cory-Slechta, D. A., Cox, C., Jusko, T. A., & Lanphear, B. P. (2003). Intellectual impairment in children with blood lead concentrations below 10 µg per Deciliter. *The New England Journal of Medicine, 348*(16), 1517-1526.
- Coulton, C., Richter, F., Kim, S.J., Fischer, R. L., & Cho, Y. (2016). Temporal effects of distressed housing on early childhood risk factors and kindergarten readiness. *Children and Youth Services Review, 68*, 59-72.
- Chandramouli, K., Steer, C. D., Ellis, M., & Emond, A. M. (2009). Effects of early childhood lead exposure on academic performance and behaviour of school age children. *Archives of Disease in Childhood, 94*, 844-848.
- Chen, A., Cai, B., Radcliffe, J., & Rogan, W. J. (2007). Lead exposure, IQ, and behavior in urban 5- to 7-year olds: Does lead affect behavior only by lowering IQ? *Pediatrics, 119*(3), e650-e658.
- Evens, A., Hryhorczuk, D., Lanphear, B. P., Rankin, K. M., Lewis, D. A., Forst, L., & Rosenberg, D. (2015). The impact of low-level lead toxicity on school performance among children in the Chicago Public Schools: a population-based retrospective cohort study. *Environmental Health, 14*(21), 1-9.
- Kaiser, M. Y., Kearney, G., Scott, K. G., DuClos, C., & Kurlfink, J. (2007). Tracking childhood exposure to lead and developmental disabilities: Examining the relationship in a population-based sample. *Journal of Public Health Management & Practice, 14*(6), 577-580.
- Liu, J., Liu, X., Wang, W., McCauley, L., Pinto-Martin, J., Wang, Y., Li, L., Yan, C., & Rogan, W. (2014). Blood lead concentrations and children's behavioral and emotional problems A cohort study. *JAMA Pediatrics, 168*(8), 737-745.
- Mendelsohn, A. L., Dreyer, B. P., Fierman, A. H., Rosen, C. M., Legano, L. A., Kruger, H. A., Lim, S. W., & Courtlandt, C. D. (1998). Low-level lead exposure and behavior in early childhood. *Pediatrics, 101*(3), 1-7.
- Miranda, M. L., Kim, D., Overstreet Galeano, M. A., Paul, C. J., Hull, A. P., & Morgan, S. P. (2007). The relationship between early childhood blood lead levels and performance on end-of-grade tests. *Environmental Health Perspectives, 115*(8), 1242-1247.
- Wasserman, G. A., Staghezza-Jaramillo, B., Shrout, P., Popovac, D., & Graziano, J. (1998). The effect of lead exposure on behavior problems in preschool children. *American Journal of Public Health, 88*(3), 481-486.
- Zhang, N., Baker, H. Tufts, M., Raymond, R., Salihu, S., & Elliott, M. (2013). Early childhood lead exposure and academic achievement: Evidence from Detroit public schools, 2008-2010. *American Journal of Public Health, 103*(3), 72-77.