Contact Hour Infection Rate Threshold Grid

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The below grid provides the potential contact hour infection rate thresholds when we compare the amount of time and the number of individuals in a particular area. It is color coded moving from Blue to Red. Blue indicates the lowest threshold = 0 since there is no contact with anyone, in other words the person is alone by themselves. The contact hours go up as the time increases and the number of individuals increases. The higher the contact hours and the greater the chance of the infection spreading. It is being suggested that contact hours be used rather than the group size because contact hours takes the number of individuals into account (Vertical Axis) as well as the amount of time (Horizontal Axis) they are together.

High	10	10	20	30	40	50	60	70	80	90	100
	9	9	18	27	36	45	54	63	72	81	90
	8	8	16	24	32	40	48	56	64	72	80
	7	7	14	21	28	35	42	49	56	63	70
	6	6	12	18	24	30	36	42	48	54	60
Num	5	5	10	15	20	25	30	35	40	45	50
	4	4	8	12	16	20	24	28	32	36	40
	3	3	6	9	12	15	18	21	24	27	30
	2	2	4	6	8	10	12	14	16	18	20
Low	1	1	2	3	4	5	6	7	8	9	10
	0	1	2	3	4	5	6	7	8	9	10
					<----	Time	---->				

The lower the contact hours, the better because it obviously decreases the chances of the spread of infection. The Green and Yellow demonstrate this while the Orange and Red contact hours do not and should be avoided. These levels could be used to advise group gatherings related to the potential spread of the COVID19 Virus which may be more effective than just addressing group size.

Contact Hour Pilot Study Validation Design: Taking Group Size, Exposure Time, & Space/Distance Into Consideration (v7)

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The purpose of this paper is to validate the key parameters for testing out the Contact Hour (CH) methodology in a series of facilities to determine its efficacy. The pilot validation study will determine if this CH methodology has any merit in being able to measure regulatory compliance with adult-child ratios. Since monitoring of facilities will not be occurring during the COVID19 pandemic are there ways to measure the research question in the previous sentence. Yes there is and it is based upon the Contact Hour (CH) methodology and involves asking the following six questions (The six questions should be asked of each grouping that is defined by a classroom or a well-defined group within each classroom tied to a specific adult-child ratio.):

1. **When does your first teaching staff arrive or when does your facility open (TO1)?**
2. **When does your last teaching staff leave or when does your facility close (TO2)?**
3. **Number of teaching/caregiving staff (TA)?**
4. **Number of children on your maximum enrollment day (NC)?**
5. **When does your last child arrive (TH1)?**
6. **When does your first child leave (TH2)?**

After getting the answers to these questions, the following formulae can be used to determine contact hours (CH) based upon the relationship between when the children arrive and leave (TH) and how long the facility is open (TO):

(1) CH = ((NC (TO + TH)) / 2) / TA;

(2) CH = (NC x TO) / TA;

(3) CH = ((NC x TO) / 2) / TA;

(4) CH = (NC^2) / TA

Where: CH = Contact Hours; NC = Number of Children; TO = Total number of hours the facility is open (TO2 - TO1); TA = Total number of teaching staff, and TH = Total number of hours at full enrollment (TH2 - TH1).

By knowing the number of contact hours (CH) it will be possible to rank order the exposure time of adults with children. Theoretically, this metric could then be used to determine that the greater contact hours is correlated with the increased non-regulatory compliance with adult-child ratios as determined in the below table on page 2.

Table 1: Contact Hour (CH) Conversion Table (RS Model(1.0)) (Fiene, 2020©)

Taking into Account Exposure Time and Density

Group Size, Staff Child Ratio, Number of Children and Staff

<---------- Adult-Child Ratios (Relatively Weighted Contact Hours) ---------->

NC	CH	1:1	2:1	3:1	4:1	5:1	6:1	7:1	8:1	9:1	10:1	11:1	12:1	13:1	14:1	15:1
1	8	**8**	8	8	8	8	8	8	8	8	8	8	8	8	8	8
2	16	**8**	**16**	16	16	16	16	16	16	16	16	16	16	16	16	16
3	24	**8**	12	**24**	24	24	24	24	24	24	24	24	24	24	24	24
4	32	**8**	**16**	16	**32**	32	32	32	32	32	32	32	32	32	32	32
5	40	**8**	13	20	20	**40**	40	40	40	40	40	40	40	40	40	40
6	48	**8**	**16**	**24**	24	24	**48**	48	48	48	48	48	48	48	48	48
7	56	**8**	14	19	28	28	28	**56**	56	56	56	56	56	56	56	56
8	64	**8**	**16**	21	**32**	32	32	32	**64**	64	64	64	64	64	64	64
9	72	**8**	14	**24**	24	36	36	36	36	**72**	72	72	72	72	72	72
10	80	**8**	**16**	20	27	**40**	40	40	40	40	**80**	80	80	80	80	80
11	88	**8**	15	22	29	29	44	44	44	44	44	**88**	88	88	88	88
12	96	**8**	**16**	**24**	**32**	32	**48**	48	48	48	48	48	**96**	96	96	96
13	104	**8**	15	21	26	35	35	52	52	52	52	52	52	**104**	104	104
14	112	**8**	**16**	22	28	37	37	**56**	56	56	56	56	56	56	**112**	112
15	120	**8**	15	**24**	30	**40**	40	40	60	60	60	60	60	60	60	**120**
16	128	**8**	**16**	21	**32**	32	43	43	**64**	64	64	64	64	64	64	64
17	136	**8**	15	23	27	34	45	45	45	68	68	68	68	68	68	68
18	144	**8**	**16**	**24**	29	36	**48**	48	48	**72**	72	72	72	72	72	72
19	152	**8**	15	22	30	38	38	51	51	51	76	76	76	76	76	76
20	160	**8**	**16**	23	**32**	**40**	40	53	53	53	**80**	80	80	80	80	80
21	168	**8**	15	**24**	28	34	42	**56**	56	56	56	84	84	84	84	84
22	176	**8**	**16**	22	29	35	44	44	59	59	59	**88**	88	88	88	88
23	184	**8**	15	23	31	37	46	46	61	61	61	61	92	92	92	92
24	192	**8**	**16**	**24**	**32**	38	**48**	48	**64**	64	64	64	**96**	96	96	96
25	200	**8**	15	22	29	**40**	40	50	50	67	67	67	67	100	100	100
26	208	**8**	**16**	23	30	35	42	52	52	69	69	69	69	**104**	104	104
27	216	**8**	15	**24**	31	36	43	54	54	**72**	72	72	72	72	108	108
28	224	**8**	**16**	22	**32**	37	45	**56**	56	56	75	75	75	75	**112**	112
29	232	**8**	15	23	29	39	46	46	58	58	77	77	77	77	77	116
30	240	**8**	**16**	**24**	30	**40**	**48**	48	60	60	80	80	80	80	80	**120**

This table is based upon the assumptions that the child care is 8 hours in length (TO) and that the full enrollment is present for the full 8 hours (TH). This is unlikely to ever occur but it gives us a reference point to measure adult child contact hours in the most efficient manner. Based upon the relationship between TO and TH based upon the algorithms, select from one of the formulae from the previous page (formulae 1 - 4) to determine how well the actual Relatively Weighted Contact Hours (RWCH) match with this table. If the RWCH exceed the respective RWCH in this table, then the facility would be over ratio on ACR standards, in other words, they would be overpopulated.

(RS Model = 1.0)

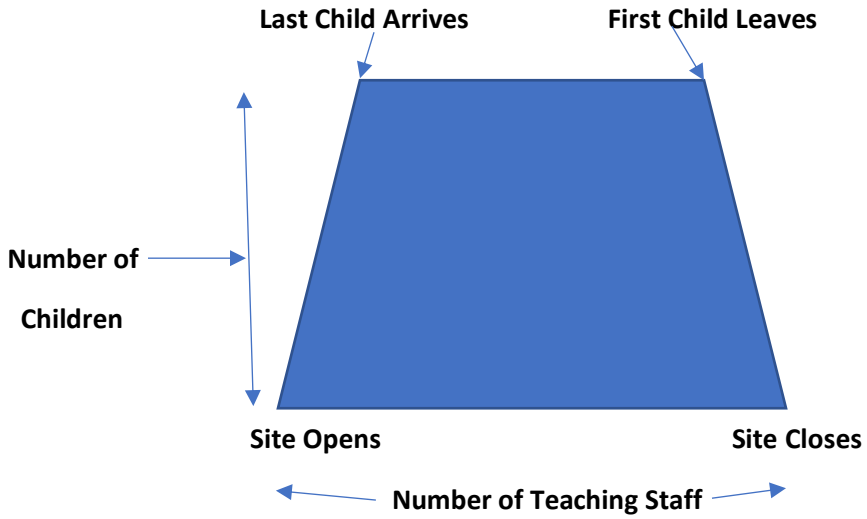
(TT Model = 0.5)

Sample/Data Collection Methods

Child care attendance data was explored and collected in partnership with the Washington State Department of Children, Youth, and Families (DCYF). A convenient sample of center and school age providers was initially identified through the use the state subsidy electronic payment system. All providers who accept Working Connections Child Care subsidies are required to use and track child attendance using an electronic attendance system. Providers may use and electronic sign in and out system provided by the state or opt to use another system. For this validation process, the sample was identified from the attendance tracking system provided and operated by DCYF and was inclusive of providers who use the system to track attendance of both subsidy and private pay children. The search resulted in approximately 100 providers within the State of Washington who have opted to use the electronic check-in system for all children regardless of payment type.

The sample was prioritized by identifying a single week since the Covid-19 outbreak began and from there the highest attendance day for that week was chosen for each provider. From this narrowed data set, it was determined the exact time the last child for the chosen day checked in, when the first child left, how many children were in attendance that day and the regular operating hours of the center or school age program. Because the attendance tracking system does not also track staffing attendance, it was necessary to contact each provider by phone in order to gather data inclusive of when the first staff arrived and when the last staff left and the total staff working that day. All responses were voluntary. Additionally, providers confirmed operating hours (many had been temporarily adjusted due to lowered demand during the gubernatorial stay at home order). Finally, providers reported if a child or staff member had tested positive for Covid-19. Of the 100 phone calls, the final sample was inclusive of 88 licensed providers statewide. Twelve providers either did not answer the call or opted to not answer the questions.

Figure 1: Contact Hour Diagram Paradigm and Schematic



The above diagram (Figure 1) depicts how the number of staff and children help to construct the contact hour formula. Depending on when the children arrive and leave could change the shape from a trapezoid to a rectangle or square or triangle. Please see the following potential density distributions which could impact these changes in the above contact hour diagram (Figure 1).

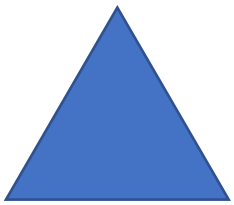
Potential Density Distributions
Taking into Account Number of Children, Staff, and Exposure Time

Here are some basic key relationships or elements related to the Contact Hour (CH) methodology.

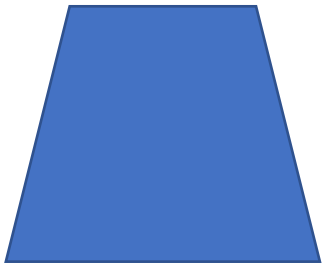
- RWCH = ACR
- CH = GS = NC
- NC and CH are highly correlated
- ACR and GS are static, not dynamic
- CH makes them dynamic by making them 2-D by adding in Time (T)
- ΣACR = GS
- GS = total number of children NC
- ACR = children / adult

ACR = Adult Child Ratio, GS = Group Size, RWCH = Relatively Weighted Contact Hours, NC = Number of Children.

Possible Density Displays of Contact Hours (Horizontal Axis = Time (T); Vertical Axis = NC):



This density distribution should result in the lowest CH but probably not very likely to occur. Essentially what would happen is that full enrollment would be a single point which means that the last child arrives when the first child is leaving. Very unlikely but possible. (TT Model Reference(0.5))



This density distribution is probably the most likely scenario when it comes to CH in which the children gradually, albeit rather steeply, arrive at the facility and also leave the facility gradually. They don't all show up at the same time nor leave at the same time. However, the arriving and leaving will be a rather close time frame. (TT Model)

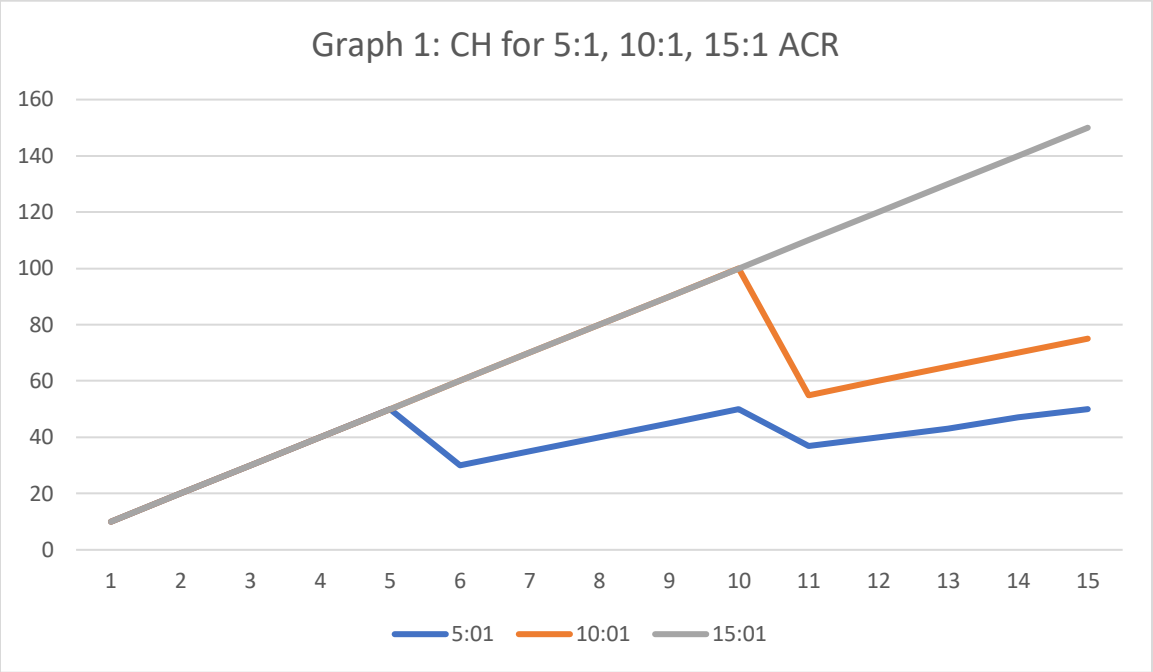
This scenario is unlikely but is used as the reference point for CH because it provides the most efficient model. This is where all the children arrive and leave at the same time. Very unlikely, but I guess it could happen. The important element here is its efficiency in that all contact hours are covered, so although a lesser amount of CH is not as efficient it does demonstrate compliance with ACR and GS which is one of the purposes of CH. As the bottom two distributions will demonstrate, CHs above this level would either depict a program that is open for an extended time or where there are too many children present and the facility is out of compliance with GS and/or ACR. (RS Model Reference(1.0))

This distribution would indicate that the facility is open for an extended time and exceeds the number of total CH as depicted in the reference square standard. Although not out of compliance with GS or ACR, this could become a determining factor when looking at the potential overall exposure of adults and children when we are concerned about the spread of an infectious diseases, such as what happened with COVID19. Are facilities that high CH because of a scenario distribution of this type more prone to the spread of infectious diseases? (RS Model)

This depiction clearly indicates a very high CH and non-compliance with ACR and GS. This is the reason for designing the CH methodology which was to determine these levels of regulatory compliance as its focus. (RS Model)

There is some overlap in the RWCH (Table 1 on page 2) in moving across the various levels, that occurs because of the change in group size (GS) where an overall group size (GS) could influence the overall CH by increasing NC.

The below graph (Graph 1) depicts the contact hours (CH) for three different adult to child ratios (ACR) 5:1, 10:1 and 15:1 to demonstrate the relationship between CH & ACR as the number of children (NC) increases. CH is along the vertical axis, with NC along the horizontal axis.



This graphic (Graph 1) depicts how with the addition of staff, the CH drop off accordingly.

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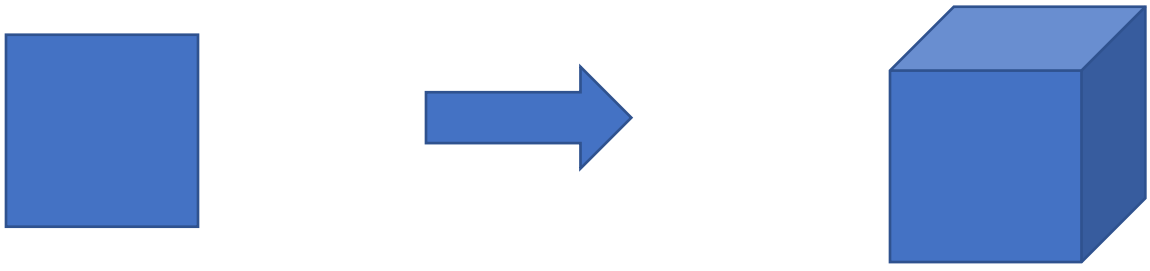
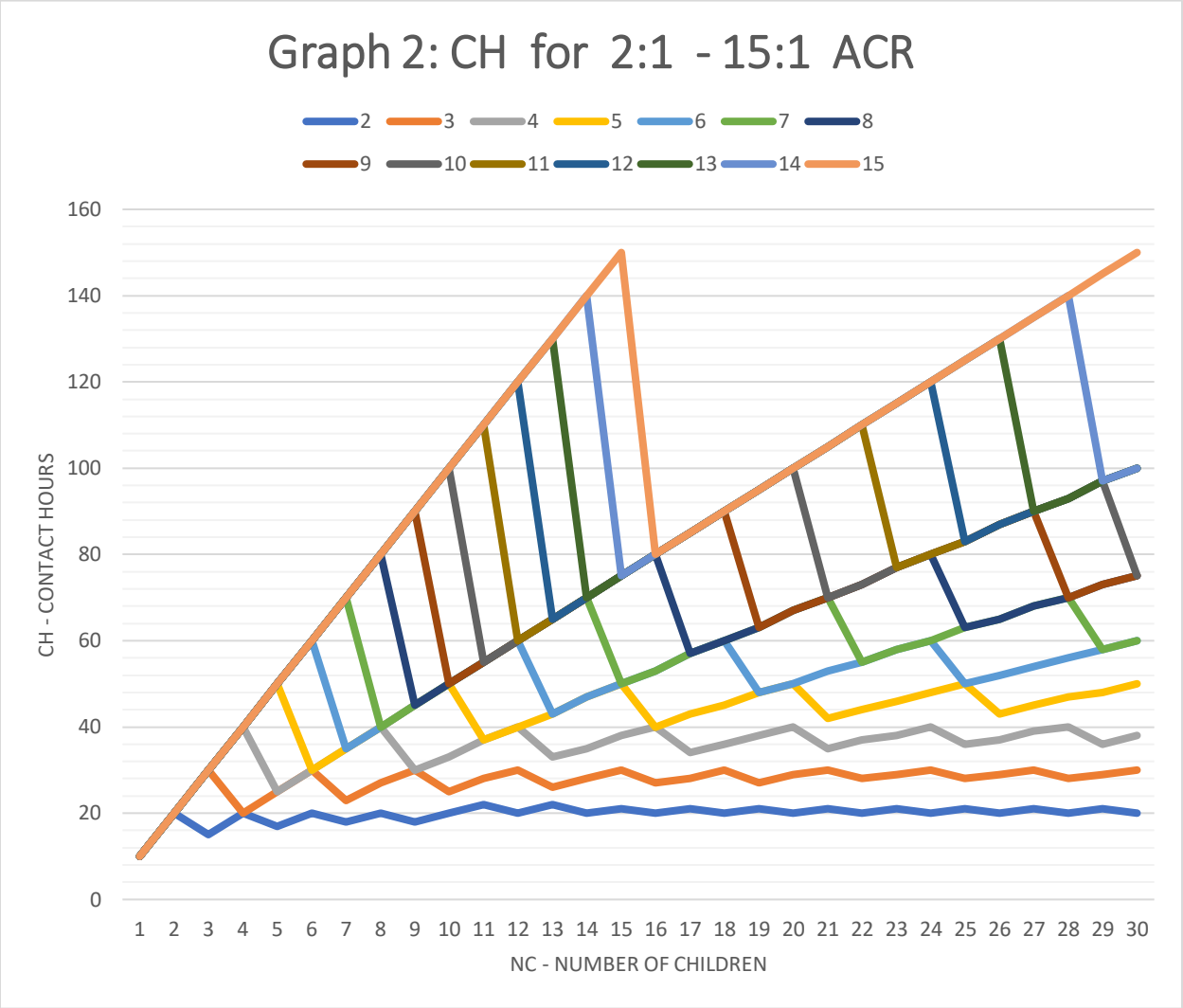
A possible extension or the next level to the CH methodology is to move from 2-D to 3-D and make the CH block format rather than area format. It could be used to describe the trilemma of accessibility, affordability and quality more fully. It could be a means for determining the unit cost at a much finer level and could then be used to make more informed decisions about the real cost of services.

Or another way of moving to 3-D is to include the square footage of the classroom or facility which would then provide a space metric along with time exposure and density metrics.



The move from 2-D (GS, ACR) to 3-D (GS, ACR, Quality or SQFT) and its potential impacts on the density distributions. Utilizing SQFT as a distancing/space dimension does help to mitigate the increased CH.

The following graph (Graph 2) depicts the Contact Hours (CH) for all the various Adult-Child ratios (ACR) in the Table on page 2 of this paper and how CH change with the number of children (NC).



From the above graph (Graph 2) it clearly shows how CHs vary with the number of children present. Please note the various slopes of the respective lines for each of the ACRs. As can be seen, once the lines begin to fluctuate, the CHs are entering into a zone of higher rate of exposure based on the ACRs. This demonstrates that the lower the ratio the more stable the CH line.

This is a listing of the algorithms for determining which formula (1-4 from page 1) & which model (RS or TT) to use in order to calculate the Contact Hours (CH). NC = Number of Children; TO = Total number of hours facility is open; TH = Total number of hours at full enrollment; TA = Total number of adult staff:

If TO = TH = NC, then (NC x TO)/TA = CH (RS Model)

If TH < TO, then ((NC (TO + TH))/2)/TA = CH; or If TH = 0, then ((NC x TO)/2)/TA = CH (TT Model)

If TO = TH < NC, then (NC x TH)/TA = CH (RS Model)

If TO = TH > NC, then (NC x TO)/TA = CH (RS Model)

Based upon the Washington State data, the Contact Hour methodology was validated in being able to act as a screener with those programs that would have exceeded the required staff child ratios. As can be seen through the data the more contact hours a staff person has with more children increases the probability of infection rates; when educators spend less time with lower amounts of children there is a lower chance of infection and vice versa. These data demonstrate how this methodology was used to assist in predicting appropriate child to adult ratios during an outbreak or pandemic by identifying safety thresholds of adult child ratios in licensed early learning facilities. The following spreadsheet plays out several scenarios with the actual data from Washington State early learning sites. For individuals interested in using the below spreadsheet in their respective jurisdiction, please contact the authors for the actual templates[1].

This provides evidence to support the use of this methodology in determining staff child ratio virtually as well as identifying when those ratios allow for in-person inspections or indicate when it is more appropriate to conduct virtual inspections. The authors do want to caution licensing administrators in that the results from this methodology is not to substitute for on-site observations when they are possible. It is intended as a screening tool to determine in a very overarching way how to target limited observational visits. The methodology is based upon statistical probabilities which have demonstrated in this pilot study to be highly reliable and valid but they are not full proof. So with any programs where there is any doubt, the agency should follow up with a direct observational inspection. Finally, agencies may want to consider using medical and geographical outbreak data in conjunction with this methodology to refine the results given the unique nature of the various infectious diseases.

In using the actual data from Washington State in the following spreadsheet, please note that the potential spread of the virus is mitigated the most greatly in the results in Green while Yellow and Red provide less mitigation and begin to place the adults and children at greater risk. Examples are provided for both the RS (1.0) and TT (0.5) Models

As a footnote to this study, a follow-up is to introduce distance/spacing via square footage (SQFT) to the Contact Hour formula. The results indicate a significant mitigation effect on increased Contact Hours when the available square footage is increased. This addition will be used in future studies to ascertain its relative impact on the Contact Hour formulas as indicated in the following revision.

$$\mathbf{CH2 = (((NC\ (TO + TH)) / 2) / TA) / (SQFT);}$$

$$\mathbf{CH2 = ((NC \times TO) / TA) / (SQFT);}$$

$$\mathbf{CH2 = (((NC \times TO) / 2) / TA) / (SQFT);}$$

$$\mathbf{CH2 = ((NC^2) / TA) / (SQFT)}$$

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Contact Hour Models

NC	TA	TO	TH	TO+TH	(TOTH)N	CH	*RWCH*	RS Model - ACRCH 5:01	10:01	15:01
10	2	8	8	16	160	80	*40*	40	80	80
20	1	12	8	20	400	200	*200*	40	80	80
30	1	12	7	19	570	285	*285*	40	80	120
5	1	8	8	16	80	40	*40*	40	40	40
15	2	8	8	16	240	120	*60*	40	60	120
9	2	12	9	21	189	94.5	*47.25*	40	80	107

NC	TA	TO	NCxTO	CH	*RWCH*	TT Model - ACRCH 5:01	10:01	15:01
10	2	8	80	40	*20*	20	40	40
20	1	8	160	80	*80*	20	40	40
30	3	8	240	120	*40*	20	40	60
5	1	8	40	20	*20*	20	20	20
15	2	8	120	60	*30*	20	30	60
25	1	8	200	100	*100*	20	33	52

TT Model = CH=((NC(TO+TH))/2)/TA=RWCH; CH=((NCxTO)/2)/TA=RWCH; if TH<TO or if TH=0

RS Model = CH=(NCxTO)/TA=RWCH; CH=(NC2)/TA=RWCH; if TO=TH=NC or if TO=TH<NC or if TO=TH>NC

Decisions:

Green = meets or under with all ACRs

Yellow = meets, under and over with ACRs

Red = over with all ACRs

Legend:

NC = Number of Children in attendance

TA = Number of Teaching Staff

TO = Number of hours site is open

TH = Number of hours site at full enrollment

CH = Contact Hours with Children

RWCH = Relatively Weighted Contact Hours with Staff

Questions:

1) Number of children in attendance on your maximum enrollment day (NC)?

2) Number of teaching/caregiving staff on that same maximum enrollment day (TA)?

3) When does your first teaching staff arrive or when does your facility open (TO1)?

4) When does you last teaching staff leave or when does your facility close (TO2)?

5) When does you last child arrive (TH1)?

6) When does your first child leave (TH2)?

TO = TO2-TO1

TH = TH2-TH1

Table of Conversions - RS Model - ACRCH (Relatively Weighted Contact Hours)

NC	CH	1:01	2:01	3:01	4:01	5:01	6:01	7:01	8:01	9:01	10:01	11:01	12:01	13:01	14:01	15:01
1	8	**8**	8	8	8	8	8	8	8	8	8	8	8	8	8	8
2	16	**8**	**16**	16	16	16	16	16	16	16	16	16	16	16	16	16
3	24	**8**	12	**24**	24	24	24	24	24	24	24	24	24	24	24	24
4	32	**8**	**16**	16	**32**	32	32	32	32	32	32	32	32	32	32	32
5	40	**8**	13	20	20	**40**	40	40	40	40	40	40	40	40	40	40
6	48	**8**	**16**	**24**	24	24	**48**	48	48	48	48	48	48	48	48	48
7	56	**8**	14	19	28	28	28	**56**	56	56	56	56	56	56	56	56
8	64	**8**	**16**	21	**32**	32	32	32	**64**	64	64	64	64	64	64	64
9	72	**8**	14	**24**	24	36	36	36	36	**72**	72	72	72	72	72	72
10	80	**8**	**16**	20	27	**40**	40	40	40	40	**80**	80	80	80	80	80
11	88	**8**	15	22	29	29	44	44	44	44	44	**88**	88	88	88	88
12	96	**8**	**16**	**24**	**32**	32	**48**	48	48	48	48	48	**96**	96	96	96
13	104	**8**	15	21	26	35	35	52	52	52	52	52	52	**104**	104	104
14	112	**8**	**16**	22	28	37	37	**56**	56	56	56	56	56	56	**112**	112
15	120	**8**	15	**24**	30	**40**	40	40	60	60	60	60	60	60	60	**120**
16	128	**8**	**16**	21	**32**	32	43	43	**64**	64	64	64	64	64	64	64
17	136	**8**	15	23	27	34	45	45	45	68	68	68	68	68	68	68
18	144	**8**	**16**	**24**	29	36	**48**	48	48	**72**	72	72	72	72	72	72
19	152	**8**	15	22	30	38	38	51	51	51	76	76	76	76	76	76
20	160	**8**	**16**	23	**32**	**40**	40	53	53	53	**80**	80	80	80	80	80
21	168	**8**	15	**24**	28	34	42	**56**	56	56	56	84	84	84	84	84
22	176	**8**	**16**	22	29	35	44	44	59	59	59	**88**	88	88	88	88
23	184	**8**	15	23	31	37	46	46	61	61	61	61	92	92	92	92
24	192	**8**	**16**	**24**	**32**	38	**48**	48	**64**	64	64	64	**96**	96	96	96
25	200	**8**	15	22	29	**40**	40	50	50	67	67	67	67	100	100	100
26	208	**8**	**16**	23	30	35	42	52	52	69	69	69	69	**104**	104	104
27	216	**8**	15	**24**	31	36	43	54	54	**72**	72	72	72	72	108	108
28	224	**8**	**16**	22	**32**	37	45	**56**	56	56	75	75	75	75	**112**	112
29	232	**8**	15	23	29	39	46	46	58	58	77	77	77	77	77	116
30	240	**8**	**16**	**24**	30	**40**	**48**	48	60	60	80	80	80	80	80	**120**

RS Model = 1.0

TT Model = 0.5

The above examples are drawn from a pilot study done with Washington DCYF ECE facilities.