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USING SIMULATION TO STUDY THE IMPACT OF COVID-19 POLICIES ON THE AVAILABILITY OF CHILDCARE

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ABSTRACT

The COVID-19 pandemic has had a profound impact on the lives of working parents, who are struggling to balance their responsibilities at work and at home, as well as childcare providers who are working hard to keep their doors open. In this paper, we examine the effect of childcare policies on the availability of childcare. Specifically, we investigate how classroom size, the likelihood of COVID-19 infection, and the number of days a classroom may need to close affect the amount of time parents will need to stay at home with their children. Our results show that even low probabilities of infection combined with stringent policies can have a large impact on the duration of a child's exclusion from childcare services.

1 INTRODUCTION

Childcare plays an indispensable role in supporting the contemporary global workforce and is critical to the success of future generations. For many working parents, access to reliable childcare is crucial to entering, returning, or remaining in the workforce. However, the COVID-19 pandemic has presented additional obstacles for securing and maintaining adequate childcare services. For instance, several studies have reported on the impact of the pandemic on childcare services and families, see for example Furman et al. (2021), Alekseev et al. (2023) and Poulain et al. (2021). Moreover, the pandemic has disproportionately affected women and mothers of children, as highlighted in studies by Almeida et al. (2020) and Moussié (2021) among others.

One of the major obstacles in finding dependable and high-quality childcare is the prevalence of small business owners running childcare facilities, as noted in Delecourt and Fitzpatrick (2021). Unfortunately, many of these facilities have been forced to close or significantly decrease their capacity due to the impact of the COVID-19 pandemic, as reported in Ali et al. (2021). This reduction in capacity was a necessary step to balance the health and safety of employees and children with the availability of the childcare service itself. Additionally, the increased operational costs required to ensure the safety of children and employees have substantially reduced revenue, making the childcare business, which already operates on a slim margin, even less financially viable.

As the pandemic continues to evolve, it is critical that policymakers and stakeholders work together to address these challenges and strengthen the childcare system. This may include providing additional support to providers, expanding access to affordable and high-quality care, and investing in strategies that promote workforce participation and economic growth. By doing so, we can ensure that children receive the care and support they need, while also supporting the wellbeing of families and the broader economy.

Many researchers have been exploring the impact of COVID-19 policies on the availability and accessibility of childcare services from a qualitative perspective, see for example Greszler and Burke

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(2020), Tupper and Colijn (2021), and Phillips et al. (2021). In particular, Schüller and Steinberg (2022) and Leng et al. (2022) study the effectiveness of different policies in reducing the spread of the virus while maintaining access to childcare services . Other researchers such as Kalluri et al. (2021) have examined the impact of policy changes on the supply and demand for childcare services, exploring the ways in which providers and families have adapted to the changing landscape of care. In this context, understanding the impact of policy changes on the availability and accessibility of childcare services has become more important than ever. The work of Gonsalves et al. (2022) provides an outline of how to use modeling for policy making in the context of Covid-19, however, it does not present any new models for assessing the impact of different policies. In this paper, we take a quantitative approach to study this relationship, using stochastic simulation to model the impact of COVID-19 policies on the availability of childcare. Moreover, unlike the literature above, this paper takes a family focus with the intention of understanding how each individual family is impacted from the policies of the daycare.

Our findings provide valuable insights into the impact of different policy scenarios on the availability of childcare services, identifying key factors that influence supply and demand. This information is critical for policymakers and stakeholders who are working to develop policies and strategies that support the wellbeing of children and families, promote workforce participation and economic growth, and ensure that all families have access to affordable, high-quality childcare services. Thus, our work contributes to the growing body of research on the impact of COVID-19 policies on childcare services, providing a quantitative perspective that can inform policy development and decision-making. This will help us create a more resilient and equitable childcare system that supports the needs of all families.

1.1 Contributions of Our Work

By using stochastic simulation applied to a childcare facility, we provide new insights to the following questions:

- How do COVID-19 policies impact the reliability of childcare?
- How do the number of students in a class affect the reliability of childcare?
- How does the probability of contracting COVID-19 affect the reliability of childcare?
- How does the mandated exclusion time when a child is infected affect the reliability of childcare?
- How do additional children increase the fraction of days staying home with sick children?

1.2 Organization of the Paper

The remainder of the paper is organized as follows. Section 2 introduces the stochastic models used for studying the impact of COVID-19 policies on childcare availability. In Section 3, we present our simulation of a daycare facility and the three different policies we implement at the daycare. In Section 4, we analyze the impact of having multiple children in a daycare facility and assess the fraction of days needed to spend at home with sick children. Finally, a conclusion and some comments on future work is given in Section 5.

2 STOCHASTIC MODELS FOR A CHILDCARE CENTER

2.1 Childcare in New York State

Childcare centers across the United States are typically governed by state regulations that aim to ensure the safety and wellbeing of children. In New York State, for instance, childcare centers are required to comply with strict child-to-teacher ratios that must be maintained at all times. This is comparable to nurse-to-patient ratios in healthcare systems, as described in Véricourt and Jennings (2011). Table 1, which is generated from NYS.Gov (2021), outlines the specific child-to-teacher ratios and maximum classroom sizes for childcare centers in New York State. These regulations are crucial in maintaining high-quality childcare services and protecting the health and safety of children.

Table 1: New York State Child to Teacher Ratios and Maximum Group Size.

Child's Age	Child to Teacher Ratio	Maximum Group Size
0 - 6 Weeks	3	8
6 Weeks – 18 Months	4	8
18 Months – 36 Months	5	12
3 Years	7	18
4 Years	8	21
5 Years	9	24
6 – 9 Years	10	20
10-12 Years	15	30

Child-to-teacher ratios are a vital component of childcare regulations as they directly impact the quality of care provided to children. These ratios define the number of children that a single teacher can supervise at any given time. The American Academy of Pediatrics Gilliam et al. (2021) recommends that childcare centers maintain a ratio of one teacher for every four infants, one teacher for every five toddlers, one teacher for every seven preschoolers, and one teacher for every ten school-age children. These guidelines help ensure that children receive the necessary level of attention and care from their teachers.

In addition to child-to-teacher ratios, states also regulate the maximum classroom size in childcare centers. The classroom size is a key factor in determining the quality of care provided to children, as overcrowding can lead to a lack of individualized attention and increase the risk of spreading infectious diseases. The maximum group size and child to teacher ratios given in Table 1 ensures that each child receives appropriate attention and care while maintaining a safe and healthy learning environment.

The Cornell University Childcare Center (C4), managed by Bright Horizons Inc., is an excellent example of a childcare facility that adheres to New York State regulations. To meet the state's guidelines, the center is organized into three distinct sections, each tailored to specific age groups. The infant section, catering to children aged six weeks to 18 months, maintains a classroom size of eight students, with a teacher-to-child ratio of 1:4. Similarly, the toddler section, accommodating children aged 18 months to three years, has a classroom size of ten students with a teacher-to-child ratio of 1:5. Finally, the pre-K section, for children aged three to five years, has a classroom size of 18 students, with a teacher-to-child ratio of 1:6. This configuration guarantees that each child receives individualized attention from their teachers, in line with state regulations.

However, it's important to note that childcare regulations can vary between different states. For instance, Texas has more lenient regulations regarding child-to-teacher ratios, as evidenced by Table 2, which is generated from Government (2023). Although these higher ratios can result in lower levels of care for children, they also often provide reduced childcare costs, which can be especially important given the high costs associated with childcare in general Ruppanner et al. (2019), Landivar et al. (2021).

2.2 Constructing the Simulation Model

In this section, we create a daycare center simulation to analyze disease transmission and estimate the number of days parents may miss work to care for their ill children. To design a comprehensive simulation, we must consider factors such as the number of children and staff, facility layout, disease type, and contact patterns. Additionally, the simulation should incorporate interventions like hand-washing, masks, and gloves during child care. By modeling various scenarios with different levels of infectiousness and compliance with preventive measures, the simulation can help predict the impact of a disease outbreak on the daycare center and estimate the number of days parents may be without care. With this information, daycare centers can implement effective policies to control disease transmission and protect the health of children and staff, while also accommodating working parents.

Table 2: Texas State Child to Teacher Ratios and Maximum Group Size.

Child's Age	Child to Teacher Ratio	Maximum Group Size
0 - 11 Month	4	10
12 Months – 17 Months	5	13
18 Months – 23 Months	9	18
2 Years	11	22
3 Years	15	30
4 Years	18	35
5 Years	22	35
6 – 8 Years	26	35
9 - 12 Years	26	35

Our simulations study is based on the design of the Cornell Childcare Center and can be extended to a wide range of classroom sizes and child-to-teacher ratios. By exploring varying values, our simulation model can provide insights into the impact of these factors on the availability of childcare and the risks associated with the spread of infectious diseases. The Cornell Childcare Center has a capacity of 180 children, aged 6 weeks to 5 years, distributed across 6 infant classes (size 8), 6 toddler classes (size 10), and 4 pre-K classes (size 18). Our work aims to analyze the effects of COVID-19 policies on childcare availability, specifically studying the impacts of classroom size, COVID-19 infection probability, and the number of days a class is closed on childcare availability over a year.

To initialize our simulation, we assume there are N children in a classroom. We create a two dimensional array of size (N , 365,000) representing the number of children as the number of rows and the number of days we want to simulate as the columns. The number 365,000 represents a simulation for 1,000 years. We begin with all children present and draw a daily Bernoulli random variable to determine if any child becomes infected. If no child is infected, the simulation continues to the next day, and the process repeats. If a child becomes infected, we move to the next day according to the daycare center's policy. Figure 1 illustrates a specific policy and how the simulation is updated daily. Finally, to obtain the values in the Figures we present in this paper, we use the sample mean of the number of days missed.

3 UNDERSTANDING POLICY IMPACT

In this section, we assess the impact of COVID-19 policies on childcare availability through a stochastic simulation of classroom dynamics. We examine policies governing how each class responds to a positive COVID-19 case and implement three distinct policies to assess their effectiveness in maintaining childcare continuity while safeguarding children, staff, and parents. By analyzing the impact of COVID-19 policies on childcare availability, our study provides valuable insights for policymakers designing appropriate policies to combat COVID-19's spread while mitigating its impact on childcare services.

3.1 Policy 1: Full Closure (Safety First)

In this section, we describe the "Safety First" policy, which prioritizes the safety and well-being of children and staff by taking COVID-19 transmission seriously and preventing its spread. If any child shows symptoms and tests positive for COVID-19, the affected classroom is immediately closed to prevent further transmission, and all children and staff in that classroom follow recommended quarantine protocols. Although this policy may disrupt normal operations, it is necessary to protect the health of children and staff and to ensure parents have confidence in the safety and reliability of childcare services.

While the "Safety First" policy is vital in mitigating the spread of COVID-19, it also presents several challenges that must be addressed. Parents must be prepared for the possibility that their children may not have care, and the policy can significantly reduce parents' ability to work. Nonetheless, it is crucial to assess the impact of this policy to create comprehensive policies that balance safety and the availability of care. For the "Safety First" policy, we make the following modeling assumptions. First each classroom has N children. Second, each child independently has probability p of having COVID-19 each school day they attend. Third, once a child contracts COVID-19, the entire class is closed for K days. Fourth, all children go to class each day that class is not closed. Lastly, Saturdays and Sundays count towards the days closed, however, they do not count as a percentage of missed days of work.

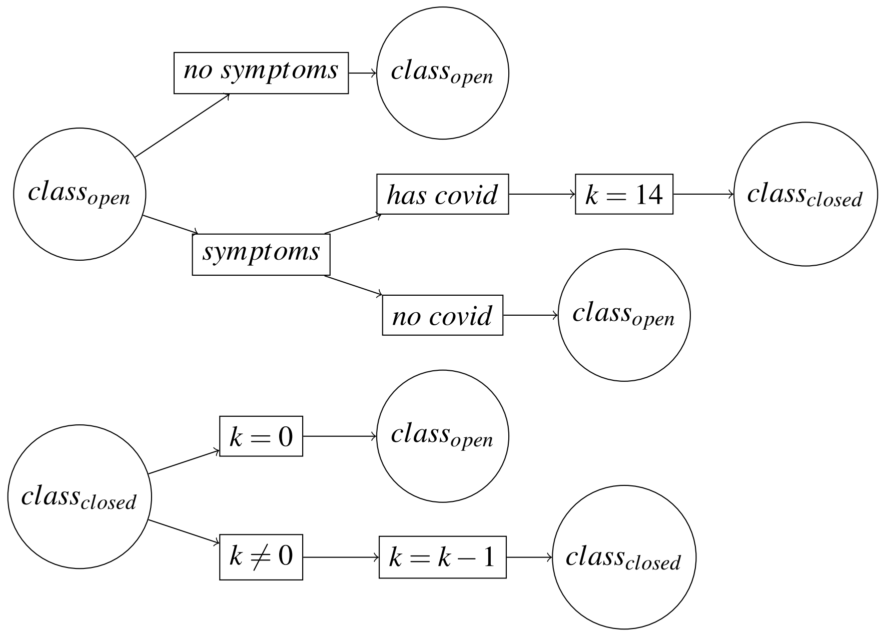

Figure 1: Policy 1 Dynamics.

Figure 1 provides a diagram of the "Safety First" policy. On the top of Figure 1, we show how a classroom transitions from open to closed and on the bottom, we show how a classroom transitions from closed to open. With the "Safety First" policy assumptions, it is possible to accurately approximate the fraction of time a child will remain out of the childcare center. This result is given below.

Theorem 1 Let N be the number of children in each classroom, K be the number of days a class will be closed for a COVID-19 exposure, and p be the probability of each child contracting COVID-19 each day. If F is the steady state fraction of days a child is out due to a class closure, then F is equal to

$$F = \frac{K}{K + \frac{1}{1-(1-p)^N}}. \tag{1}$$

Proof. Since we are interested in the fraction in steady state, it suffices to analyze the problem on one cycle. One cycle will include a period where the classroom is open and one period where the classroom is closed for K days. Thus, it remains to understand the expected time that a classroom is open.

In order to gain a better understanding of the amount of time that a classroom may remain open before closure due to COVID-19, it is necessary to consider the probability that a child will arrive at the classroom already infected with the virus. This probability is represented by the variable p, and since there are N children in the classroom, the probability that none of the children are infected is given by $(1-p)^N$.

By modeling each day as a Bernoulli random variable with success probability $(1-p)^N$, we can determine the expected amount of time until a child contracts COVID-19. Specifically, the time until a classroom closure can be modeled by a geometric random variable with success probability $(1-p)^N$, which represents the number of days until the first occurrence of a COVID-19 case.

With this model in place, we can calculate the mean time to classroom closure or the amount of time the classroom is open until closure occurs. This is given by the formula $1/(1-(1-p)^N)$, which takes into account the probability of success (i.e., a COVID-19 case occurring) and the number of children in the classroom. This completes the proof. $\square$

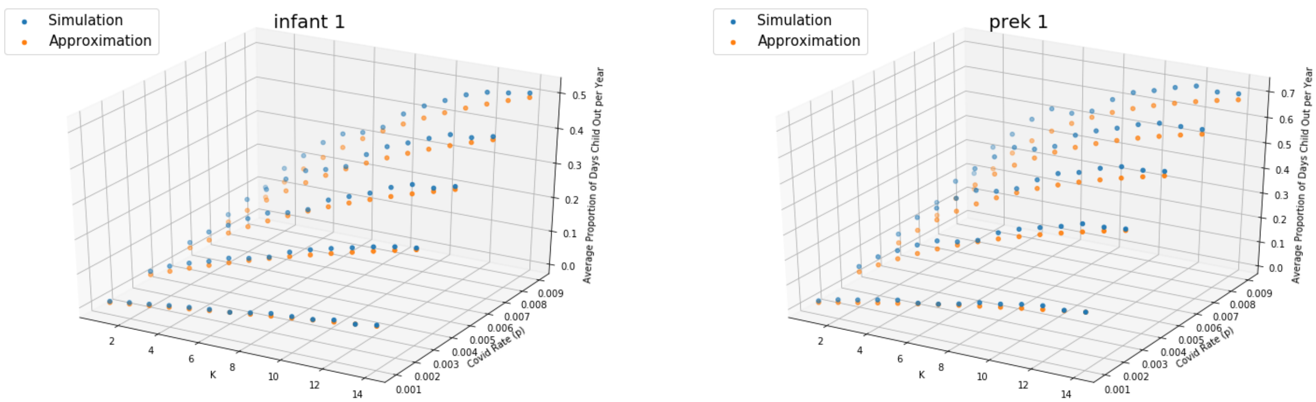

Figure 2: Policy 1 (Safety First): (K vs. p) Surface Plot for $N = 8$ children (left). (K vs. p) Surface Plot for $N = 18$ children (right).

Our mathematical result given in Theorem 1 has some simplifying assumptions, and other factors not accounted for, such as asymptomatic cases or the effectiveness of safety measures. If teachers have the same probability of contracting COVID-19 as children, the model could be adjusted by increasing the value N. However, Theorem 1 offers a starting point for understanding COVID-19 transmission within a classroom setting, and can inform policies and guidelines for childcare during the pandemic. It helps childcare providers make informed decisions on managing risks, ensuring safety, and calculating income loss due to COVID-19 closures.

To assess the quality of our result in Theorem 1, we simulate the dynamics of an infant and pre-school classroom and compare our results to the formula presented in Equation 1. Figure 1 provides two surface plots that compute the fraction of time out of daycare as a function of the infection probability p and the mandated number of days the classroom must close K. On the left of Figure 1, it is assumed the classroom size is equal to 8 students and on the right there are 18 students in the classroom. We find that the our formula given in Theorem 1 does a great job of approximating the fraction of time that a child spends out of daycare. Note that the largest discrepancy is seen on days 3, 4 and 5 and increases as the probability of infection increases. This is because the if K is equal to 3,4, or 5, then the fraction of missed days can vary according to what day the center closes. If $K = 3$ and the center closes on a Friday, then only one real day is missed. However, if $K = 3$, and the center closes on Monday, then three days are missed. However, for $K = 7$, there are always 5 days missed.

We also observe that as the infection probability is increased and the number of children are increased that the fraction of days without care increases although at a diminishing rate. Thus, children are slightly more likely to be out in the pre-school class since there are more children to take into account.

3.2 Policy 2: No Closure (Test to Stay)

Introducing the second policy considered in this paper, the “Test to Stay” policy aims to prevent the spread of COVID-19 in educational institutions. It requires students and staff in close contact with someone who has tested positive to take a COVID test. A negative test result allows them to continue attending school or work, while a positive result requires self-isolation at home. Proven effective in various schools and institutions worldwide, this policy enables education to continue with minimal disruption, ensuring safety and well-being of all involved (Schechter-Perkins et al. 2022; Campbell et al. 2022).

The “Test to Stay” policy is based on Cornell Childcare Center’s current COVID-19 policy, which excludes infected children for K days. However, to reduce the chances of other children contracting the virus, the remaining children and staff members are required to undergo testing for the next five days. To capture this exposure risk, our simulation model increases the probability of each child getting infected to p^h for five days. The duration of the testing mandate can be adjusted and is denoted by the variable $M \in \mathbb{N}$ and the higher probability of infection can also be modified for any situation.

For the “Test To Stay” policy, we make the following modeling assumptions. First each classroom has N children. Second, each child independently has probability p of having COVID-19 each school day unless an infected child is excluded where the remaining students are forced to test and the infection probability is increased to p^h for M days. Third, once a child contracts COVID-19, the infected child is removed for K days and the entire class is forced to test for M days. Fourth, all children go to class each day they are not excluded. Lastly, Saturdays and Sundays count towards the days closed, however, they do not count as a percentage of missed days of work.

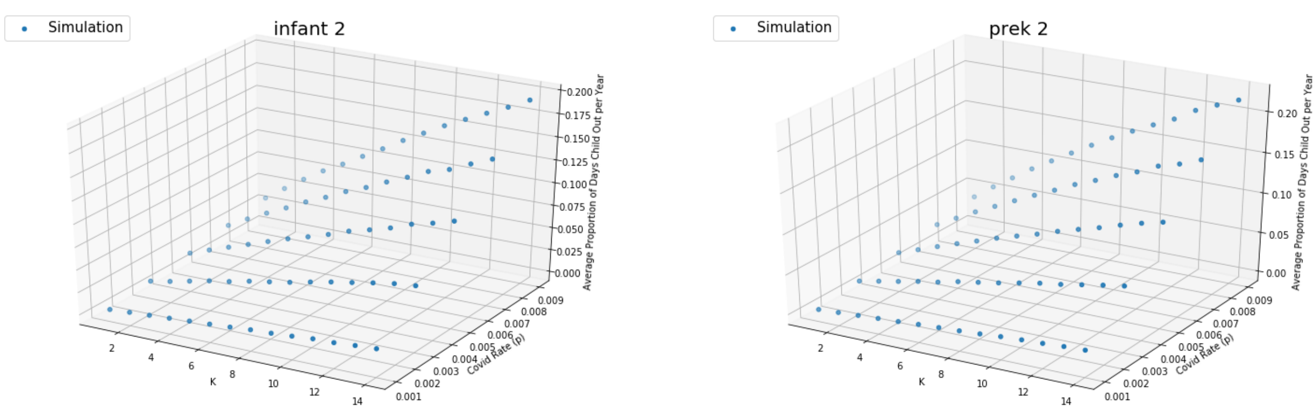

Figure 3: Policy 2 (Test to Stay): (K vs. p) Surface Plot for $N = 8$ children (left). (K vs. p) Surface Plot for $N = 18$ children (right).

In Figure 3 we simulate how the “Test to Stay” policy would work in an infant and pre-school classroom. Figure 3 displays two surface plots that show the fraction of time a child is excluded from daycare, based on the infection probability p and the mandated exclusion duration K for the infected child. On the left of Figure 3, we assume a classroom size of $N = 8$, while on the right of Figure 3, we assume $N = 18$. We observe that as the infection probability and number of children increase, there is a slight rise in the fraction of days without care, but it plateaus eventually. In the pre-school class, children are slightly more likely to be excluded due to the larger class size. Compared to the “Safety First” policy, the “Test to Stay” policy results in a three-fold decrease in the fraction of days without care, thus reducing the number of days parents must miss work under the ”Test to Stay” policy.

3.3 Policy 3: Partial Closure Plus Test

In this section, we introduce the third and final policy that we consider in this paper. Policy 3 is a hybrid approach, which aims to mitigate the spread of COVID-19 in daycare centers by specifying a set of measures to be taken when a child contracts the virus. Under this policy, the affected classroom must close for a certain number of days (K), and all children must test negative for COVID-19 for a specified period (M) before returning to daycare. Compared to Policy 1, which mandates a ten-day closure period, the value of K in Policy 3 is generally smaller. However, all remaining children and staff members are required to undergo COVID-19 testing for the following five days, which may increase the likelihood of other children contracting the virus. To account for this, our model adjusts the probability of each child contracting COVID-19 to p^h for the next five days. Overall, Policy 3 represents a balanced approach that aims to limit the impact of COVID-19 on daycare operations while minimizing the risk of transmission among children and staff members.

For the "PARTIAL CLOSURE" policy, we make the following modeling assumptions. First each classroom has N children. Second, each child independently has probability p of having COVID-19 each school day unless a child becomes infected. Third, once any child contracts COVID-19, the class is closed for K days and the entire class is forced to test for M days after the closure is complete. Fourth, all children go to class each day they are not excluded. Lastly, Saturdays and Sundays count towards the days closed, however, they do not count as a percentage of missed days of work.

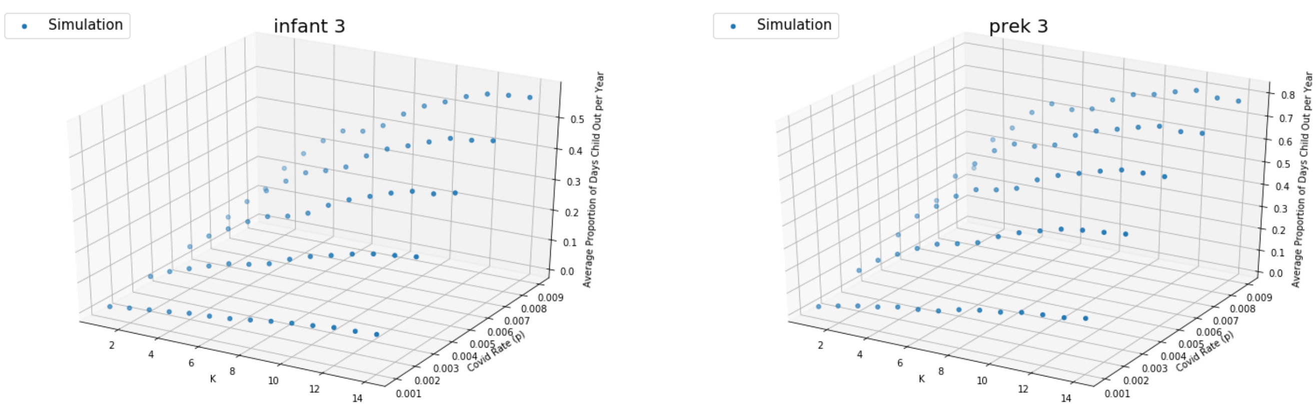

Figure 4: Policy 3 (Partial Closure Plus Test): (K vs. p) Surface Plot for $N = 8$ children (left). (K vs. p) Surface Plot for $N = 18$ children (right).

Figure 4 presents two surface plots that depict the fraction of time a child is excluded from daycare, given the infection probability p and the mandated exclusion duration K for the infected child. The left plot assumes a classroom size of $N = 8$, while the right plot assumes $N = 18$. The study finds that as the infection probability and classroom size increase, there is a slight increase in the fraction of days without care, but it eventually plateaus. Notably, children in pre-school classrooms are slightly more likely to be excluded due to the larger class size.

The hybrid policy results in a higher fraction of days without care compared to both the "Safety First" and "Test to Stay" policies, leading to an increase in the number of days parents must miss work under the "Test to Stay" policy. However, the hybrid policy can strike a balance between the two policies if the number of closed days is less than the number of closed days in the "Safety First" policy. Overall, this study highlights the importance of considering the trade-offs between different policies to ensure the well-being of both children and their families.

4 EXTENSION TO MULTIPLE CHILDREN

Many parents are fortunate to have more than one child, however, it can come with challenges when it comes to balancing work and family responsibilities. One significant challenge is the increased likelihood of having to take time off work due to child sickness. When children attend daycare, they are more susceptible to illness, and with each additional child, the risk of exposure increases. When a child falls ill, one or both parents may need to stay home to care for the child, which can result in lost wages, missed deadlines, and decreased productivity. Furthermore, as the number of children in a family increases, these situations may occur more frequently, making it challenging for parents to maintain a consistent work schedule. While having children is very rewarding, it can also be a significant source of stress for working parents, especially when it comes to balancing work and family responsibilities. In this section, we examine the impact of having multiple children in daycare and aim to assess the number of additional days needed to care for multiple children when they are sick and unable to attend daycare.

4.1 Two Children or More

If parents have two children, it's commonly assumed that they would attend different classrooms. As a result, there are six distinct possibilities for two children. These possibilities are as follows: (1) both are infants, (2) one is an infant and the other is a toddler, (3) one is an infant and the other is in pre-school, (4) both are toddlers, (5) one is a toddler and the other is in pre-school, and (6) both are pre-schoolers.

In order to approximate the effectiveness of the "Safety First" policy, we can utilize the inclusion-exclusion principle. If we assume that the two children are independent, we can calculate the probability that at least one child will be out, and subsequently determine the fraction of time that a parent with two children will spend at home with their children. This approximation can be expressed as follows:

$$\begin{aligned} \mathbb{P}(\text{at least one child out}) &= \mathbb{P}(\text{child 1 out}) + \mathbb{P}(\text{child 2 out}) - \mathbb{P}(\text{both children out}) \quad (2) \\ &\approx \mathbb{P}(\text{child 1 out}) + \mathbb{P}(\text{child 2 out}) - \mathbb{P}(\text{child 1 out}) \cdot \mathbb{P}(\text{child 2 out}) \quad (3) \end{aligned}$$

By utilizing the inclusion-exclusion principle in conjunction with Theorem 1, we can approximate the likelihood of at least one child being absent and use this information to determine the fraction of time that a parent with two children will be able to spend at home with their children. This approach allows us to better understand the potential impact of the "Safety First" policy on a family's daily routine with multiple children.

$$\mathbb{P}(\text{at least one child out}) \approx \frac{K}{K + \frac{1}{1-(1-p)^{N_1}}} + \frac{K}{K + \frac{1}{1-(1-p)^{N_2}}} - \frac{K}{K + \frac{1}{1-(1-p)^{N_1}}} \cdot \frac{K}{K + \frac{1}{1-(1-p)^{N_2}}}. \quad (4)$$

Figure 5 presents the simulation results for the "Safety First" policy with two different two-child scenarios. The left plot of Figure 5 shows the fraction of days missed when one child is in an infant classroom and the other in a toddler classroom, while the right plot shows the fraction of days missed when one child is in an infant classroom and the other in a pre-school classroom. In both plots, we observe that the inclusion-exclusion principle approximation accurately approximates the fraction of days missed with two children. Additionally, we find that a parent would need to take between 30-50% more days off work to care for a second child under this policy, depending on the types of classrooms that the children are in. These results highlight the significant impact that having multiple children in daycare can have on a parent's ability to maintain a consistent work schedule, particularly when policies prioritize safety and require children to stay home when sick.

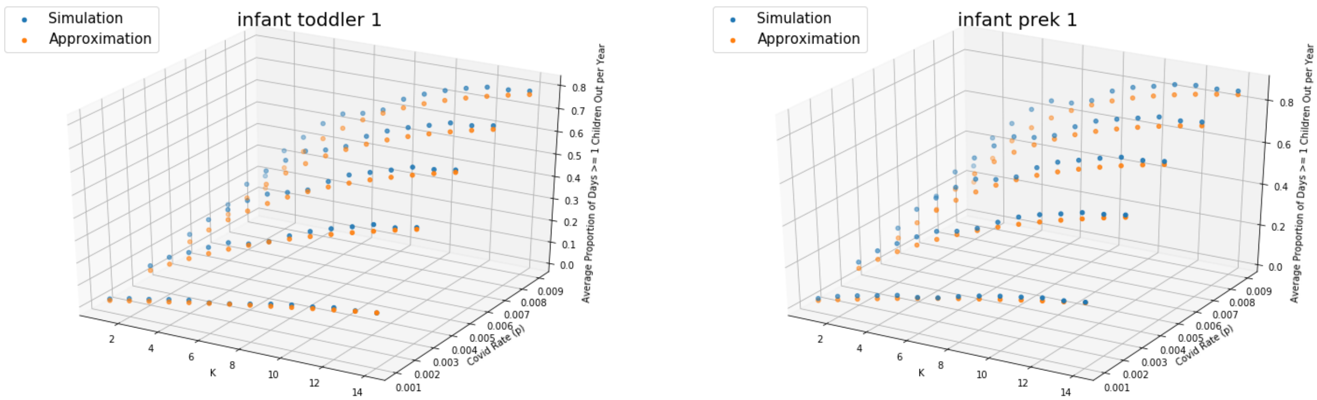

Figure 5: Policy 1 (Safety First with Two Children): (K vs. p) Surface Plot for Infant and Toddler Classrooms (left). (K vs. p) Surface Plot for Infant and Pre-School Classrooms (right).

Figure 6 shows the results of our simulations for two different policies, “Safety First” and “Test to Stay,” with one child in an infant classroom, the second in a toddler classroom, and the third in a pre-school classroom. The left plot displays the fraction of days missed under the “Safety First” policy, while the right plot shows the fraction of days missed under the “Test to Stay” policy. Notably, we observe that the inclusion-exclusion principle approximation accurately approximates the fraction of days missed with three children. Moreover, when compared to the scenario with two children, we find that a parent would need to take an additional 5-15% more days off work to care for the third child. Furthermore, the right plot of Figure 6 shows that having three children under the “Test to Stay” policy almost doubles the fraction of days a parent will need to miss due to sick children. Thus, having multiple children can have a significant impact on a parent’s ability to maintain a consistent work schedule.

5 CONCLUSION & FUTURE DIRECTIONS

In recent times, the COVID-19 pandemic has brought about a significant impact on various aspects of society, including childcare services. In this paper we analyze the impact of COVID-19 policies on the availability of childcare. To evaluate the effects of COVID-19 policies on the availability and reliability of childcare services, simulation is used as a tool. We find that very strict polices like the “Safety First” policy significantly reduces the availability of childcare despite small infection probabilities for the children. We also find that “Test to Stay” is very effective in keeping people safe and still providing care for the non-sick children. A hybrid policy that combines ”Safety First” and ”Test to Stay” strikes a nice balance between the two policies. Finally, we also find that families with multiple children are even more exposed to more illnesses and the unavailability of childcare.

Although we have a better understanding of how the implementation of COVID policies impact the access to childcare, expanding the scope of the research would provide policymakers and childcare service providers with valuable insights into the unique challenges faced by families with multiple children during the COVID-19 pandemic. By understanding the impacts of COVID-19 policies on such families, policymakers can design policies that are more inclusive and tailored to meet the needs of a broader section of society. Additionally, this research helps parents decide what childcare services they should choose since many providers have different sick policies.

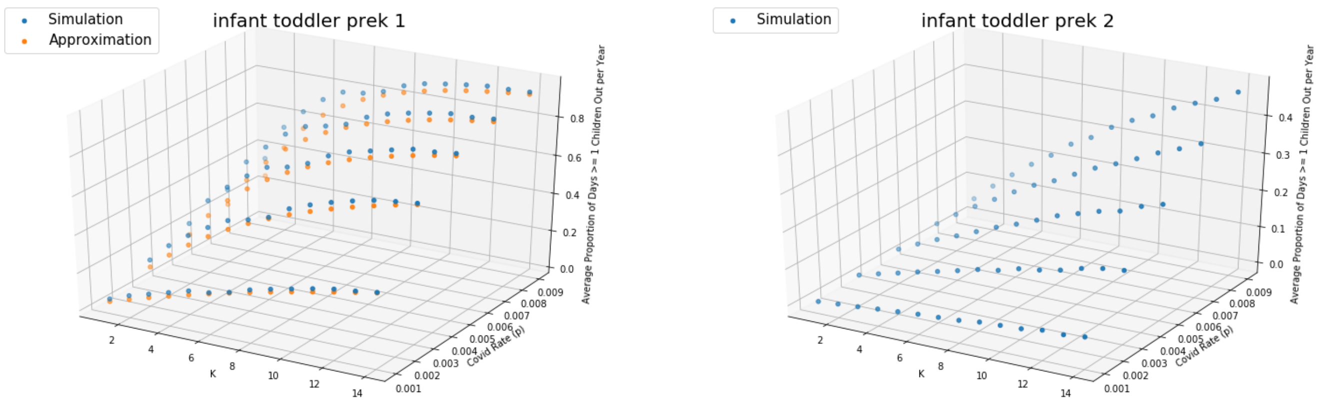

Figure 6: Policy 1 and 2: (K vs. p) Surface Plot for Infant, Toddler, and Pre-School Classrooms Under Policy 1 (left). (K vs. p) Surface Plot for Infant, Toddler, and Pre-School Classrooms Under Policy 2 (right).

In the future, we plan to explore the possibility of designing "sick-kid" daycare centers for moderately ill children. These centers would be staffed with healthcare professionals alongside standard childcare providers. Our simulation model can be used to estimate the arrival rate to these centers. In our design, we plan to use Hawkes processes to model the arrivals of sick children since Hawkes processes capture self-excitement and contagion effects, see for example Daw and Pender (2018) and Daw and Pender (2022). It would be important to see the utilization of the facility and potential blocking during waves of illness.

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