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Infant life jacket donning trials using children and their parents: Comparison to the Canadian standard

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ABSTRACT

Introduction: Canadian drowning rates for children are high and an increased demand for child flotation devices with novel designs is expected. This experiment was conducted to: 1) record the donning performance of life jackets on children/infants using the methods outlined in the Canadian standard; and 2) to compare the donning performance results to the previously reported results using a soft manikin.
Method: Four different child life jackets were procured for evaluation. Adults and their children were recruited from the Halifax region to participate.
Results: Fifty-five participants completed at least one donning trial with one of the four life jackets. Findings were in general agreement with the previous manikin study. Manikin testing showed consistent results with human testing for life jackets that are both well designed or poorly designed, but were not consistent for "mediocre" life jackets. Each sub-task added 10 s to the donning process. Incorrect donning was yet again caused by clips and ties that were not colour and/or size coded.
Conclusions & recommendations: A manikin may be offered as an alternative for a human in the donning tests. For "mediocre" life jackets that fail the manikin test, a human test can always be used to clarify the situation.

1. Introduction

Between 1991 and 2000, the Canadian Red Cross found drowning to be the fourth most common cause of unintentional death in Canada; it was only surpassed by highway accidents, falls and poisoning, respectively (Canadian Red Cross, 2003). The majority of actual drowning deaths (n = 4671) and near drowning deaths (n = 3289) occurred during recreational or sporting activities, while the two most at risk populations in rank order were adult males, followed by youth and infants/children between the ages of 1–4 years. Although the majority of child drowning deaths occurred in pools and bathtubs, adult/infant recreational activities in open water seem to be occurring more frequently. Thus, the Transport Canada, Marine Safety Branch is anticipating that there will be a higher demand for child flotation devices and have noticed an increase in requests for approval of flotation devices with novel designs (Murray, 2008).

The majority of drowning deaths in Canada are believed to be preventable by wearing flotation devices when in or around water, as supported by Brooks (Brooks, 1995). In Europe and Canada, flotation devices are commonly referred to as life jackets, a device that "provides face up in-water support to the user regardless of the physical condition of the user" (International Standards Organization, 2006). All flotation devices evaluated in this study are recognized by regulating authorities as life jackets and will be referred to as such. In addition, for simplicity all infant/child life jackets will be called children's life jackets.

In 1991, Funkhouser and Fairlie (Funkhouser and Fairlie, 1991) evaluated 4 children's life jackets under ideal conditions and found that life jackets with a complex design increased the time to don. In 2001, this finding was further explored by Coleshaw et al. (Coleshaw et al., 2001), who found that fathers could only don 3 out of 5 children's life jackets on their child in less than or equal to 1-min. The authors stated that the primary cause of the increased donning time was due to the complicated design of the crotch strap.

In 2011, MacDonald et al. (MacDonald et al., 2011) extended this work and evaluated 8 children's life jackets. Due to the possibility that the behaviour of a child might confound the results of the donning procedure, a deliberate decision was made to have the

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parents/guardians (adults) don the life jacket on a soft manikin. It was noted that as the number of sub-tasks required to don the life jacket increased, donning time increased by an average 10 s per task and donning accuracy (correct donning) decreased. These findings were in agreement with Funkhouser and Fairlie in 1991 (Funkhouser and Fairlie, 1991) and Coleshaw et al., in 2001 (Coleshaw et al., 2001). It was also found that a learning effect existed when adults attempted to don more than one life jacket on to a soft infant manikin in the same session (MacDonald et al., 2011). Regardless of life jacket type, there was a significant reduction in donning time between the first and second attempt at donning, but not between the second and all subsequent attempts. This finding was consistent with that of Funkhouser and Fairlie (Funkhouser and Fairlie, 1991), who found that although the effect of order did not yield a significant difference, there was an average 11.6-s drop in donning time between the first and second attempt. This finding has consequences for test houses that tend to use experienced people to act as test subjects. If the jacket is intended for use of an occasional or novice user then using experienced test subjects will significantly underestimate the actual donning time of a less experienced user. The MacDonald et al. (MacDonald et al., 2011) study clearly showed that if this practice continues, then some poorly designed life jackets may be incorrectly approved.

Based on the requirements outlined in Section 6.9, 6.10 and 6.11 of the Canadian life jacket standard CAN/CGSB-65.7-2007 (Canadian General Standards Board, 2007), the main purpose of this study was to record the donning performance of four representative life jackets on children using the methods outlined in the Canadian standard. The second purpose was to compare the donning performance results on children to the previously reported results using a soft manikin (MacDonald et al., 2011), and use adults and their children as subjects in the donning procedure. For a child life jacket to receive certification it must meet the following donning performance criteria (in water performance will be reported in a separate paper):

- Donning time: The time in seconds required to complete a donning in $\leq$1-min;
- Donning accuracy: The measured accuracy of completing a donning 100% correctly by $\geq$80% of participants on their first attempt, and 100% correctly by 100% of participants on their second attempt;

The experiment was approved by the Dalhousie University Ethics Committee and the work was conducted under a grant from the Transport Canada, Marine Safety Branch.

2. Material & methods

2.1. Procurement of representative child life jackets

Eight children's life jackets were evaluated in the original experiment (MacDonald et al., 2011) using a soft manikin. Due to the learning effect that was noted in the original study (MacDonald et al., 2011), each adult in this study was only required to don one life jacket on their child. Principally, due to the difficulty of recruiting adults and children and allowing only one donning per subject, the total number of life jackets chosen was reduced to four of the original eight. Each life jacket was inherently different from the others with respect to the performance type, number of sub-tasks and the location of ties, zips and clips. By the sheer fact of these differences, of the 4 life jackets chosen, both the simplest and best performing life jacket in the previous study, and the most complex and worst performing life jacket ended up being included. Table 1 presents a breakdown of the total number of sub-tasks required to don each life jacket correctly, as well as how the total number of sub-tasks is divided, by type of sub-task. For example, life jacket A requires 5 total sub-tasks to be completed for a correct donning, and these 5 sub-tasks include: (1) placing the child in the life jacket; (2) zipping a zipper; (3) clipping one clip; (4) clipping a second clip; and (5) adjusting all straps.

Life jackets B, C & D were procured from outside of Canada and were therefore not approved for use in the Canadian market place; while life jacket A had been approved under the recently rescinded CGSB/CAN-65.7-M88 standard (Canadian General Standards Board, 1988). Until now, Canada has had a very conservative policy on child life jacket design; and so, there are very few design options for customers wishing to purchase “approved” life jackets. This was one of the benefits for conducting this experiment using life jackets which were not approved in Canada; so that we could possibly identify other novel child life jacket designs which may have the potential for future approval in Canada, under the new standard.

2.2. Establishment of the donning procedure

To evaluate donning accuracy, an ordered list of the critical tasks necessary to don each life jacket was created by a group of marine survival instructors, who had a combined knowledge of over 60 years of experience in sea survival training. The list was formulated to specify the optimal order/sequence in which the sub-tasks should be completed. Sufficient flexibility was permitted to allow an alteration in task sequences without directly leading to a failure of the donning procedure. This list formulated the basis of the measurement of donning accuracy and an example is presented in Table 2.

This critical list of sub-tasks was used to compare the order in which each participant completed the donning task. If a participant elected to complete a life jacket donning in a different sequence than the one identified by the experts, it was not necessarily deemed a failure as long as all critical sub-tasks were completed at the end of the process. For instance, to correctly don life jacket B, the zipper should be zipped up before connecting the chest clip. However, it was possible to connect the chest clip buckle before zipping the zipper, so as long as both sub-tasks were completed at the end of the donning process; it was considered an accurate donning.

2.3. Choice of participants and group allocation

Participants were chosen using a sample of convenience from Dalhousie University and the surrounding Halifax, Nova Scotia, Canada region. Adults and their children were allocated to life jacket groups based on: i) their experience in and around open water; and ii) their experience with donning life jackets. This information was gathered via questionnaire administered to each adult prior to testing. Based on the answers to the questionnaire, adults were stratified by experience and then randomly assigned into life jacket groups A, B, C or D. Once allocated, it was then determined if the adult would allow their child to attempt a self-donning without the adult's assistance. If the adult allowed this donning procedure to occur, then the child was given the first opportunity to attempt a self-donning. The success or failure of the child's self-donning was noted, after which the adult started the donning procedure again from the beginning. The donning trial performed by the child was not viewed by the adult although the adult was present in the room.

2.4. Donning instructions

Section 6.9 of the Canadian standard states that prior to the

Table 1
Total number & types of sub-tasks for each life jacket.

Life jacket	Total# of sub-tasks required to complete donning	Types of sub-tasks				
		Place child in jacket	# of zips	# of clips	# of ties	Adjust all straps
A	5	1	1	2	0	1
B	6	1	1	2	1	1
C	7	1	0	5	0	1
D	5	1	0	2	1	1

Table 2
An example of the critical sub-tasks required to correctly don life jacket B and the optimal sequence in which these tasks should be completed.

Life jacket B required sub-tasks	Optimal donning sequence
Place child in jacket	1
Zip up zipper	2
Attach chest clip	3
Attach crotch clip	4
Tie up tie	5
Tighten all straps	6

commencement of a life jacket approval trial, each subject is to be given the simple instructions, “please don the life jacket as quickly as possible and adjust to fit snuggly” (Canadian General Standards Board, 2007). By giving each subject this standardized instruction and information, it was possible to record how a subject who may be unfamiliar with the product would perform the donning process.

In the original protocol, it was decided that children would be instructed not to assist the adult during the donning process (i.e. to not help start to and zip up zippers, connect clips, etc.). However, after further review of the standard, it was noted that no specific direction exists as to whether the child is permitted to assist the adult in the donning procedure or not. Based on anthropometric data gathered by McDowell et al. (McDowell et al., 2008), children who meet the Canadian standards anthropometric guidelines may range in age from 1 month to 11 years old. As reported by Santrock et al. (Santrock et al., 2011), a significant difference in motor skill development exists among children within this age range. The authors reported that generally, children aged 2 years or younger have a limited ability to perform basic fine motor skills, whereas children around age 8.5 years have typically developed these skills and are able to apply them to simple tasks (Santrock et al., 2011). Since a wide range of motor abilities may exist among children who are expected to wear the same life jacket, it was reasonable to expect that some of the children participating in the study would be capable of conducting an unassisted self-donning. For this reason children were given the opportunity to attempt a self-donning.

2.5. Observations during evaluation

During each adult donning trial, a measure of the child's “compliance” was recorded by both the Principal Investigator (PI) and the parent. This compliance measure was taken so that any problems encountered during testing could be noted and used either to provide feedback to the manufacturer, or to improve the wording in the standard, or both.

2.6. Procedure

Before commencement of the donning procedure, adult participants signed an informed consent in accordance with the Dalhousie University Ethics Committee guidelines, completed the experience questionnaire, and had their child's height, body mass and chest circumference (CC) measured.

Section 6.9 of the Canadian standard states that child life jackets are intended for children with a body mass of $\leq$18 kg $\pm$ 1 kg and a CC of $\leq$625 mm $\pm$ 25 mm (Canadian General Standards Board, 2007). All children who participated in this study fell within these anthropometric ranges.

2.6.1. Child self-donning

If an adult allowed their child to attempt a self-donning, the adult remained in the room and faced away from the testing area. The child was then given the simple instructions and presented with a covered box containing the life jacket specific to their group (as previously described in Section 2.3). When ready, the box lid was removed and the life jacket was revealed; at which point the child commenced donning while the PI recorded the time and accuracy of the donning. Each child received just one attempt at donning (regardless of their accuracy or speed). Once the child's attempt was completed, the life jacket was removed from the child by the PI and returned to the covered box. If a child was unable to complete the donning procedure on his/her own, the PI provided assistance to help complete the donning process so that the child did not become discouraged. All assistance provided by the PI was noted, however the trial was considered a failure if assistance was provided.

2.6.2. Adult donning on child

On the first trial, each adult was given the simple instructions and then presented with a covered box containing the life jacket specific to their group (described above in Section 2.3). When ready, the box lid was removed and the life jacket revealed, then the adult began his/her attempt at donning while the PI recorded the time and accuracy of the donning. If the adult participant completed the donning incorrectly or in greater than 1-min, the lifejacket was removed by the PI and the adult was shown a 3-min video demonstrating how the life jacket was to be donned correctly. After viewing the demonstration the adult attempted a second donning trial while following the same procedure as Trial 1.

2.7. Data reduction and analysis

The measurements of donning time and donning accuracy were collected using a stop-watch and the devised forms and recorded in Microsoft Excel 2003. Descriptive statistics of mean, standard deviation, minimum and maximum donning time were calculated for each life jacket. In addition, the frequency of passes and failures for both donning accuracy and donning time were analyzed. In Minitab version 15®, an ANOVA (General Linear Model) was performed to test for any differences in age of adults, as well differences in age, body mass, height and CC for children among the four life jacket groups. The One-way ANOVA was also used to compare the donning times across the four lifejackets with a post-hoc Tukey's test to compare the mean times among the lifejackets. The time data were also converted to pass-fail tabular data and compared using the

Chi-squared analysis. For all statistical comparisons a critical alpha of 0.05 was chosen. In some instances data transformation was required and a Johnson Transformation (Kotz and Johnson, 1993) was applied using Minitab version 15®. The Johnson Transformation evaluates three functions of "Bounded System" (SB), "Log-normal System" (SL) and "Unbounded System" (SU) with the current estimates of four data parameters. Once transformed, the data is then run with a normality test to determine which of the three transformation functions produces the best normality test result (Kotz and Johnson, 1993).

3. Results

3.1. Participants

Fifty-five (55) adults participated in the donning process on their child. They consisted of 37 females and 18 males with a mean age of 35.1 years (±5.7 years), while one female declined to reveal her age, she appeared to be around the mean of the sample. Adults were stratified for life jacket and water experience and balanced into one of four life jacket groups. A total of 13 participants were assigned to life jacket group A; 15 participants were assigned to life jacket group B; 13 participants were assigned to life jacket group C; and 14 participants were assigned to life jacket group D. There was no significant difference in mean age of the adults between any of the life jacket groups, regardless of sex. Descriptive statistics for all adult participants and life jacket groups are presented in Table 3.

The children consisted of 32 females and 23 males with a mean age of 3.1 years (±1.3 years), a mean body mass of 14.9 kg (±2.8 kg) and a mean CC of 540 mm (±30 mm). No significant differences were found for any main effects of age, mass, or CC between any of the life jacket groups, regardless of sex. Descriptive statistics for all child participants and life jacket groups is presented in Table 4.

3.2. Child donning performance and time

Only 4 adults allowed their child to attempt a self-donning. By chance, two children aged 3 and 4 attempted to don life jacket A, which was identified in the previous study as the easiest life jacket to don as it passed all donning time and accuracy criteria; while 2 children aged 2 and 3 attempted to don life jacket C, which was identified in the previous study as being the most difficult life jacket to don and failed all donning time and accuracy criteria. All 4 children failed the donning procedure on both life jackets. All required the assistance of the PI to complete the donning process. With this assistance the donning procedure was ultimately completed successfully. The time required to don life jacket A was 51.3 and 134.6 s, while life jacket C was donned in 98.3 and 114.3 s. All 4 children got confused over the technique required to start the zip, and the different ties, buckles, and clips. Some children gave up earlier than others. For instance, one child donning life jacket A gave up very quickly, but with PI assistance the life jacket was still donned correctly in under 1-min. A second child fought and struggled with the same life jacket and unwillingly gave up well after the 1-min mark. At this point the PI took an additional thirty seconds to unravel the straps and complete the correct donning.

3.3. Adult donning performance and time

3.3.1. Trial 1

The results of Trail 1 for the adults donning the life jacket on their children are presented in Table 5.

The mean donning time for life jacket groups A, B, C and D was 34.0 s (±12.6 s), 54.6 s (±16.8 s), 70.5 s (±30.8 s) and 61.6 s (±18.5 s), respectively. By combining both time and accuracy measures of all four life jacket groups, the number of successful attempts at life jacket donning were 13 (100%), 11 (73%), 6 (46%), and 9 (64%) for life jacket groups A, B, C and D, respectively. Thus, only one of the four life jackets (A) was donned correctly in ≤1-min by more than 80% of participants on the first attempt. Common donning errors were attributed to the possibility of making incorrect connections between straps and buckles, complex and unfamiliar design of the life jackets and the increased number of sub-tasks required to don each life jacket correctly.

The donning time data was checked for normality using the Shapiro-Wilkes test and found to be not normally distributed so the data was then transformed using the Johnson Transformation method in Minitab. The transformed data was analyzed using a One-way ANOVA in Minitab to compare among the four lifejackets. This produced a significant main effect of life jacket type ($p < 0.01$) and the post-hoc test found that the mean donning time for lifejacket A (34 s) was significantly less than the jackets C (71 s) and D (62 s), but did not differ from lifejacket B (55 s); and there were no differences in donning times among the lifejackets B, C & D.

The donning time data was also compared non-parametrically by converting the individual donning times of each life jacket to pass-fail scores. This data was compared using the Chi-squared analysis where it was determined that lifejacket A was significantly ($p < 0.05$) easier to don (100% pass); while lifejacket C was the most difficult (43% passed). There was no difference ($p < 0.05$) between lifejackets B and D, but both were more difficult than A and easier than C.

There were two very noticeable and improper methods of donning which were attempted during Trial 1. In one case an adult donned life jacket D on their child completely back-to-front (i.e. with the principal buoyancy of the life jacket reversed from the front of the chest to the back); while in a second case an adult donned life jacket D on their child upside-down (i.e. with the principal buoyancy of the life jacket inverted from behind the head to below the waist). Although this life jacket did not have an excessive number of associated sub-tasks required for a complete donning (5), it did have the most unusual design which was not familiar or intuitive to the user.

During the Trial 1 donning process, 2 children assisted the adult with the donning procedure by connecting the chest clip on their own (life jackets A and B). This assistance led to the quickest time for their entire group. Both children were 4 years old. Life jacket A was donned in only 18.3 s, which was 3.3 s faster than the second

Table 3
Total number (n) and ages of all adult participants per life jacket (LJ) group.

Adults	Total (n)	Females (n)	Males (n)	Mean age (yrs.)	SD age (yrs.)	Min age (yrs.)	Max age (yrs.)
LJ Group A	13	9	4	33.1	6.4	24	42
LJ Group B	15	9*	6	37.1	6.6	27	52
LJ Group C	13	9	4	34.9	3.2	28	40
LJ Group D	14	10	4	35.0	5.8	26	42
All adults	**55**	**37**[a]	**18**	**35.1**	**5.7**	**24**	**52**

[a] One female declined to reveal her age; so "All Adults" and "LJ Group B" age values are based on 54 and 14 participants, respectively.

Table 4
Total number (n) and ages of all child participants per life jacket (LJ) group.

Children	Total (n)	Females (n)	Males (n)	Mean age (yrs.)	SD age (yrs.)	Min age (yrs.)	Max age (yrs.)
LJ Group A	13	10	3	3.2	1.5	1	7
LJ Group B	15	6	9	3.2	1.3	1	4
LJ Group C	13	8	5	2.6	0.9	1	4
LJ Group D	14	8	6	3.2	1.3	2	6
All Children	**55**	**32**	**23**	**3.1**	**1.3**	**1**	**7**

Table 5
Results of trial 1 for adults donning on their children.

Life jacket	Mean donning time (sec)	SD donning time (sec)	Donning accuracy, including time (#)	Donning accuracy, including time (%)
A	34.0	12.6	13	100
B	54.6	16.8	11	73
C	70.5	30.8	6	46
D	61.6	18.5	9	64

shortest time for that group; while life jacket B was donned in only 30.5 s, which was 6.0 s faster than the second shortest donning time for that group.

3.3.2. Trial 2

The results of Trail 2 for the adults donning the life jacket on their children are presented in Table 6.

All 13 adult participants successfully donned life jacket A on their first attempt, so it did not require a second donning trial. A total of 4, 7 and 5 adults were required to don life jackets B, C and D a second time, respectively. However, one adult from life jacket group B and one adult from life jacket group C withdrew from testing, stating that they did not want to volunteer their child for another donning trial and put them through the whole testing procedure again. Therefore, the total number of participants remaining in life jacket groups B, C and D were 3, 6 and 5, respectively.

After observing the specific video donning instructions, the mean donning time for life jacket groups B, C and D was 36.7 s (±13.5 s), 60.3 s (±12.8 s) and 31.7 s (±6.9 s) for the 14 remaining adults, respectively. By combining both time and accuracy measures of all 3 life jacket groups, the number of successful attempts at life jacket donning were 3 (100%), 2 (33%), and 5 (100%) for life jacket groups B, C, and D, respectively. The 4 (67%) adults who failed their second overall donning requirement with life jacket C did finally don the life jacket on their child correctly; but all exceeded the 1-min requirement. This failure to don the life jacket in less than or equal to 1-min was primarily caused by life jacket C having the most associated sub tasks (7).

3.4. Number of sub-tasks and donning time

When the number of sub-tasks required to don a life jacket is correlated to the donning time required for completion of the life jacket (Fig. 1), there is a significant relationship ($r = 0.36$, $p < 0.05$) between the increase in sub-tasks (correct placement of child, zip, clip, tie, adjust) and an increase in donning time.

4. Discussion

Our purposes were to record the donning performance of a representative group of child life jackets on children and to compare our findings from the donning trials using a manikin to those where an adult donned the life jacket on a child. The two studies demonstrated several positive and consistent findings. On the one hand, they showed that a well-designed life jacket such as A was significantly easier to don. It naturally rested in the anatomical shape of the child during donning and resembled a vest which was familiar to both the child and adult in their personal clothing. On the other hand, they also showed that a serious design flaw could also be detected in which a life jacket could be placed on the back of the child rather than the chest, etc. (life jacket D). In agreement with Funkhouser and Fairlie (Funkhouser and Fairlie, 1991) and Coleshaw (Coleshaw et al., 2001), it was shown that the number of sub-tasks is directly related to an increase in donning time, and if the buckles and clips are not colour and size coded, the number of errors increases.

New findings revealed the issue of whether a child should be permitted to assist the adult in the donning procedure. Four children attempted a self-donning on their own without the adult. None came close to succeeding. However, during the adult donning trials, two children assisted their parents which led to the fastest donning times for each of their life jacket groups. At this stage we cannot answer the question of whether child assistance would allow a “mediocre” life jacket to pass the life jacket test. For the present, we would recommend that the child should remain passive during the donning process.

The adults and the PI did not find any case in which the child disliked a particular life jacket due to the design of the life jacket. Two (4%) adults made valid comments about improvements that could be made to the donning procedure which would make their child more comfortable and behave better. One adult believed that the life jacket being tested (A) could have been made slightly larger for their child, even though the child was within the anthropometric limits of the life jacket. The second adult comment stated

Table 6
Results of trial 2 for adults donning on their children.

Life jacket	Mean donning time (sec)	SD donning time (sec)	Donning Accuracy, including time (#)	Donning Accuracy, including time (%)
A	n/a	n/a	n/a	n/a
B	36.7	13.5	3	100
C	60.3	12.8	2	33
D	31.7	6.9	5	100

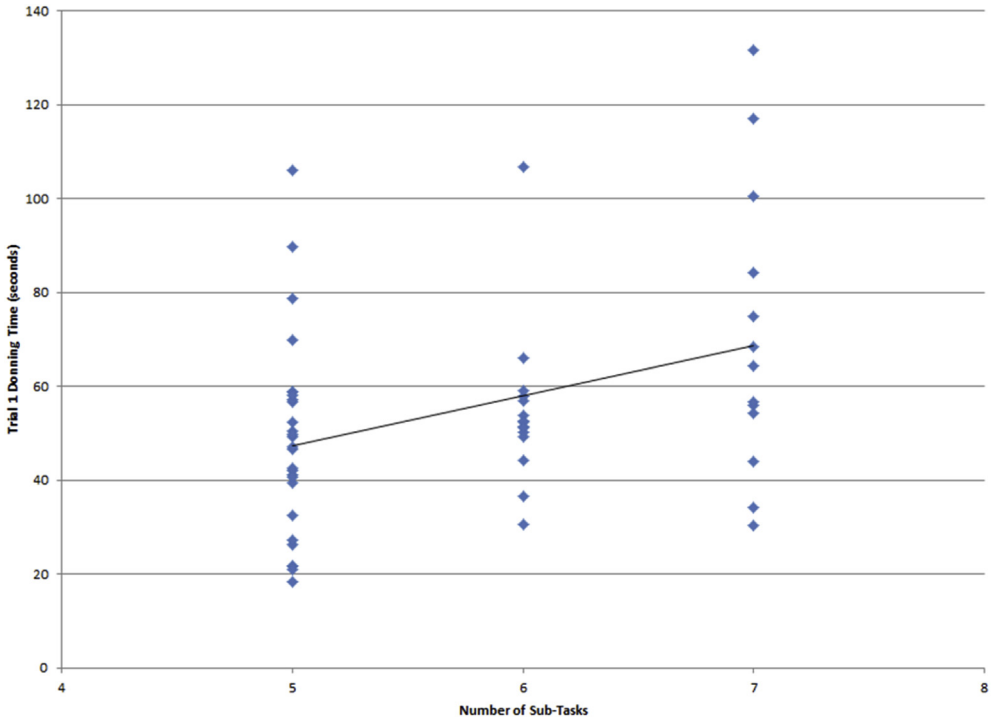

Fig. 1. Donning time (seconds) for each life jacket versus the number of sub-tasks required to don.

that there should be fewer donning trials attempted since their child became resistant as the process continued (this is the reason why two adults took their children out of the second trial).

Only one of the four life jackets (A) was donned correctly and within the time limit on the first attempt; while life jackets B and D were donned correctly and within the time limit on the second attempt. Although the success of life jacket A and the failure of life jacket C were consistent between the human and manikin trials; life jackets B and D were inconsistent as they passed in the human trials but failed in the manikin trials. This evidence suggests that the manikin is a better, more reliable and stringent method of testing. Fundamentally this is a good feature, but it may cause the rejection of some lifejackets that could be considered "mediocre" and may be just barely acceptable. To compensate for this, we would suggest that the regulators offer the manufacturers and the test houses the option of using a human or manikin for their donning approval trials. We support the use of a manikin in the donning approval process and in an upcoming paper will also show it to be more reliable for testing of the life jacket in water. We would also support the idea that if the life jacket fails the donning test with the use of a manikin, then test houses should still have the option of re-testing the life jacket with a human. This is not a new concept. For example, the Canadian marine survival suit standard (Canadian General Standards Board, 1999) offers both manikin and human testing for the thermal test. There is another advantage to this policy, in the case where a lifejacket fails the manikin test, and either passes or fails the human test, it would add more information to our data bank on manikin testing compared to human testing.

5. Conclusions

1 Life jacket design effects adult donning performance on children.
2 The results with human testing for life jackets that are both well designed or poorly designed are consistent with manikin testing, but are not consistent for "mediocre" life jackets.
3 A good life jacket should have a minimum number of sub-tasks, colour and size coded clips and straps, and design of the life jacket should be intuitive to the wearer by resembling street clothing.
4 If a child is used during testing, they should remain passive and not assist in the donning procedure.

6. Recommendations

The option of both manikin and human testing for donning trials should be offered in the Canadian infant/child life jacket standard.

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